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PROFESSIONALS IN CHEMISTRY: 1983 - 1984

A Digest of Information about The Chemical Profession

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INTRODUCTION AND ACKNOWLEDGEMENT

This edition of Professionals in Chemistry is a collection of edited writings and statistical tables that analyze five aspects of the chemical profession during 1983-1984 and the near future. Included are chapters on education, earnings, employment, demographic information and research and development funding.

The first chapter is concerned with the education of chemists and chemical engineers. Data presented here are from studies of the number of degrees granted in the chemical sciences, the representation of women and minority groups in this population and projections of the number of high school students - potential recruits to chemistry-to the year 2000. An excerpt from Sue E. Berryman's book, Who Will Do Science? raises questions about the future participation of women and minorities in scientific occupations. Other studies contribute data on undergraduate curriculum ratings by ACS members, post-graduation plans of new graduates at all degree levels and the sources of support for students in graduate school.

In the second chapter, studies of earnings in the chemical sciences are brought together in a number of comparative contexts in order to provide a full picture of the economic rewards of chemistry and chemical engineering. In addition to the presentation of starting salaries and those of experienced chemists, a statistical regression model quantifies employment characteristics that affected salaries in 1984. Comparison data for chemists' salaries and "middle-class" budget requirements in ten urban areas are shown. Other salary comparisons are made as well: chemists and all U.S. workers and chemists compared with other scientists and engineers.

Chapter III, on employment and demographic characteristics, contains information on the state of the profession in 1983-1984. In addition to tables and figures, three papers discuss employment during this period. National Science Foundation data is used to project trends in employment in the chemical sciences for the next five years.

The final chapter deals with actual and projected funding of research and development generally and funding of the chemical sciences specifically. A short essay by Louis Schorsch of the U.S. Congressional Budget Office provides an evaluation of federal R&D funding. 1983-84 federal R&D budgets that deal with the chemical sciences are presented, including a separate series of tables containing data from the National Science Foundation. Because most R&D in the chemical sciences is privately funded, a special series of tables presents private sector R&D expenditures before and during 1983-84.

Professionals in Chemistry was prepared by the ACS Office of Statistical Services. Dr. Terrence Russell edited the report and compiled the tables that are included. Mrs. Nguyen Bailey prepared the text and supervised publication of the book.

Bob Jones, Manager
Statistical Services

CHAPTER I

EDUCATION

*

THE SCIENTIFIC TALENT POOL: EMERGENCE AND CHANGE

Sue E. Berryman
The RAND Corporation

To increase a subgroup's representation among quantitative degrees, policymakers have two choices. They can try to increase the group's share of the initial mathematical/scientific talent pool by more than any increase in its attrition from it, or try to reduce the group's attrition from the pool by more than any decrease in its share of the initial pool. In either case, policymakers need to know *when* action can be taken most effectively.

We find that the scientific/mathematical pool from which quantitative Ph.D. graduates ultimately derive first appears in elementary school. It emerges strongly before the 9th grade and is essentially complete by the 12th. The pool appears to reach its maximum size prior to senior high school and subsequently declines in size through graduate school.

Before the 9th grade, membership in the pool is defined more by quantitative interests than by skills. Children whose career interests require college differ in their substantive interests but not in their mathematical, verbal, and scientific skills. However, by the 12th grade, membership is defined both by mathematical/scientific interests and by significantly higher mathematical achievements. This distinction continues through graduate school, those planning a quantitative graduate degree having higher quantitative skills than those planning a nonquantitative degree.

Although the talent pool seems to reach its maximum size before high school, migration into the pool continues to occur during grades 9 through 12. However, *after high school migration is almost entirely out of, not into, the pool*. As a consequence, those who obtain quantitative doctorates or have quantitatively oriented careers a decade after high school come overwhelmingly from the group who in grade 12 had scientific and mathematical career interests and high mathematical achievement scores.

These results have two major policy implications. First, strategies to increase the size of the initial scientific/mathematical pool of minorities and women should be targeted before and during high school. Second, strategies to decrease attrition from the pool can be targeted at any point in the process, since attrition from the pipeline and from quantitative fields occurs at all points.

Source: Who Will Do Science, by Sue E. Berryman, The Rockefeller Foundation, November 1983.

Table 1.1.1

1978/79 PERCENT FEMALE IN QUANTITATIVELY-BASED FIELDS* BY DEGREE LEVEL

Degree Level	Percent Female in Quantitatively-Based Fields	Ratio of % Female in Quantitatively-Based Fields to % Female of Total Degrees	Ratio of % Female in Quantitatively-Based Fields to % Female of Age-Relevant Population
B.A.	25	0.51	0.50
M.A.	18	0.37	0.36
Ph.D.	15	0.50	0.30
Professional Degree	25	0.93	0.50

* Quantitatively-based fields for the B.A., M.A., and Ph.D. are defined to include the physical sciences, mathematics, computer sciences, biological sciences, engineering, and economics. For professional degrees the fields are biologically- or physically-based and defined to include medicine, dentistry, optometry, osteopathy, podiatry, veterinary medicine and pharmacy.

SOURCE: Who Will Do Science, by Sue E. Berryman, The Rockefeller Foundation, November 1983.

1978/79 REPRESENTATION OF RACIAL AND ETHNIC GROUPS BY DEGREE LEVEL

Racial and Ethnic Group	Degree Level				
	Associate Degree	B.A.	M.A.	Ph.D.	Professional Degree
Total	100.0	100.0	100.0	100.0	100.0
Whites	82.3	88.1	88.5	90.8	91.2
Blacks	9.1	6.6	6.9	4.4	4.2
Hispanics	5.1	3.3	2.0	1.6	2.5
American Indians	0.6	0.4	0.4	0.4	0.3
Asian-Americans	1.9	1.7	2.0	2.8	1.8

SOURCE: Who Will Do Science, by Sue E. Berryman, The Rockefeller Foundation, November 1983.

Table 1.1.3

1978/79 REPRESENTATION RELATIVE TO REPRESENTATION IN THE AGE-RELEVANT POPULATION BY DEGREE LEVEL AND RACIAL AND ETHNIC GROUP

Racial and Ethnic Group	Degree Level				
	Associate Degree	B.A.	M.A.	Ph.D.	Professional Degree
Whites	1.04	1.11	1.10	1.11	1.14
Blacks	0.70	0.51	0.58	0.41	0.35
Hispanics	0.86	0.62	0.36	0.31	0.45
American Indians	0.86	0.57	0.66	0.66	0.50
Asian-Americans	1.27	1.13	1.05	1.33	0.95

SOURCE: Who Will Do Science, by Sue E. Berryman, The Rockefeller Foundation, November 1983.

1978/79 REPRESENTATION IN QUANTITATIVELY-BASED FIELDS* RELATIVE TO REPRESENTATION IN AGE-RELEVENT POPULATION BY DEGRZE LEVEL AND RACIAL AND ETHNIC GROUP

Racial and Ethnic Group	Degree Level			
	B.A.	M.A.	Ph.D.	Professional Degree
Whites	1.13	1.12	1.12	1.12
Blacks	0.32	0.21	0.16	0.35
Hispanics	0.55	0.29	0.21	0.47
American Indians	0.43	0.50	0.33	0.50
Asian-Americans	1.93	2.79	2.71	1.58

* Quantitatively-based fields for the B.A., M.A., and Ph.D. are defined to include the physical sciences, mathematics, computer sciences, biological sciences, engineering, and economics. For professional degrees the fields are biologically- or physically-based and defined to include medicine, dentistry, optometry, osteopathy, podiatry, veterinary medicine and pharmacy.

SOURCE: Who Will Do Science, by Sue E. Berryman, The Rockefeller Foundation, November 1983.

Table 1.1.5

Annual High School Graduates
Fifty States and the District of Columbia
Actuals 1975-1982, Projected 1983-2000

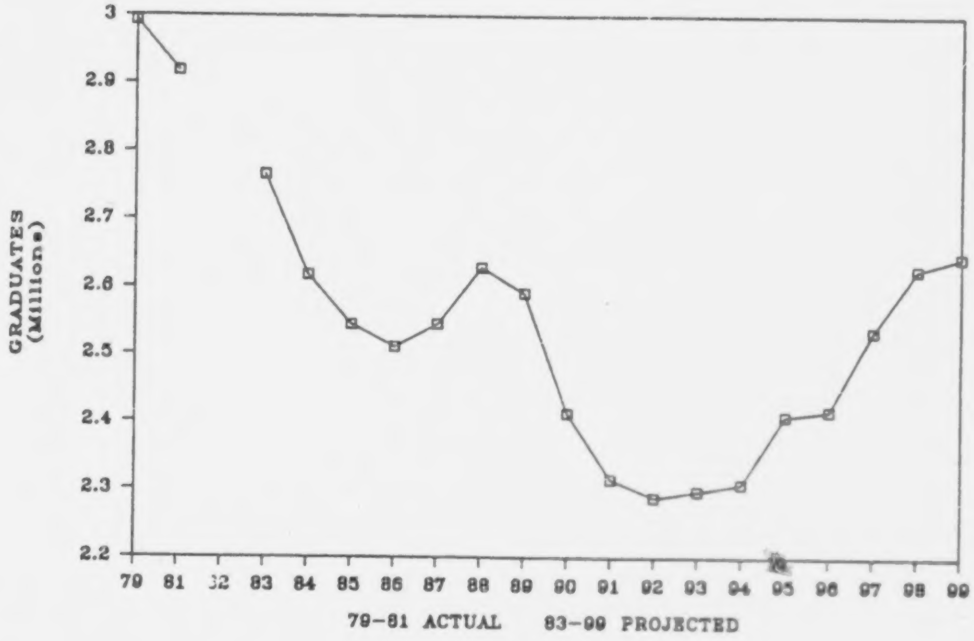
YEAR	U.S. TOTAL
1975-76	2,916,246
1976-77	2,932,920
1977-78	2,972,697
1978-79	2,992,802
1979-80	2,928,734
1980-81	2,918,310
1981-82	2,845,451
1982-83	2,766,167
1983-84	2,618,523
1984-85	2,544,477
1985-86	2,510,512
1986-87	2,544,583
1987-88	2,628,940
1988-89	2,590,718
1989-90	2,411,755
1990-91	2,314,974
1991-92	2,288,063
1992-93	2,297,415
1993-94	2,308,099
1994-95	2,408,721
1995-96	2,416,395
1996-97	2,535,132
1997-98	2,627,302
1998-99	2,645,824
1999-00	2,156,288

Source: High School Graduates: Projections for the Fifty States (1982-2000), Western Interstate Commission for Higher Education.

Figure 1.1.6

UNITED STATES PROJECTIONS

TOTAL HIGH SCHOOL GRADS 1983-1999



Source: High School Graduates: Projections for the Fifty States (1982-2000), Western Interstate Commission for Higher Education.

Table 1.1.7

States Included in Each Region

Northeast Region

Connecticut
Delaware
District of Columbia
Maine
Maryland
Massachusetts
New Hampshire
New Jersey
New York
Pennsylvania
Rhode Island
Vermont

Northcentral Region

Illinois
Indiana
Iowa
Kansas
Michigan
Minnesota
Missouri
Nebraska
North Dakota
Ohio
South Dakota
Wisconsin

Southeast-Southcentral Region

Alabama
Arkansas
Florida
Georgia
Kentucky
Louisiana
Mississippi
North Carolina
Oklahoma
South Carolina
Tennessee
Texas
Virginia
West Virginia

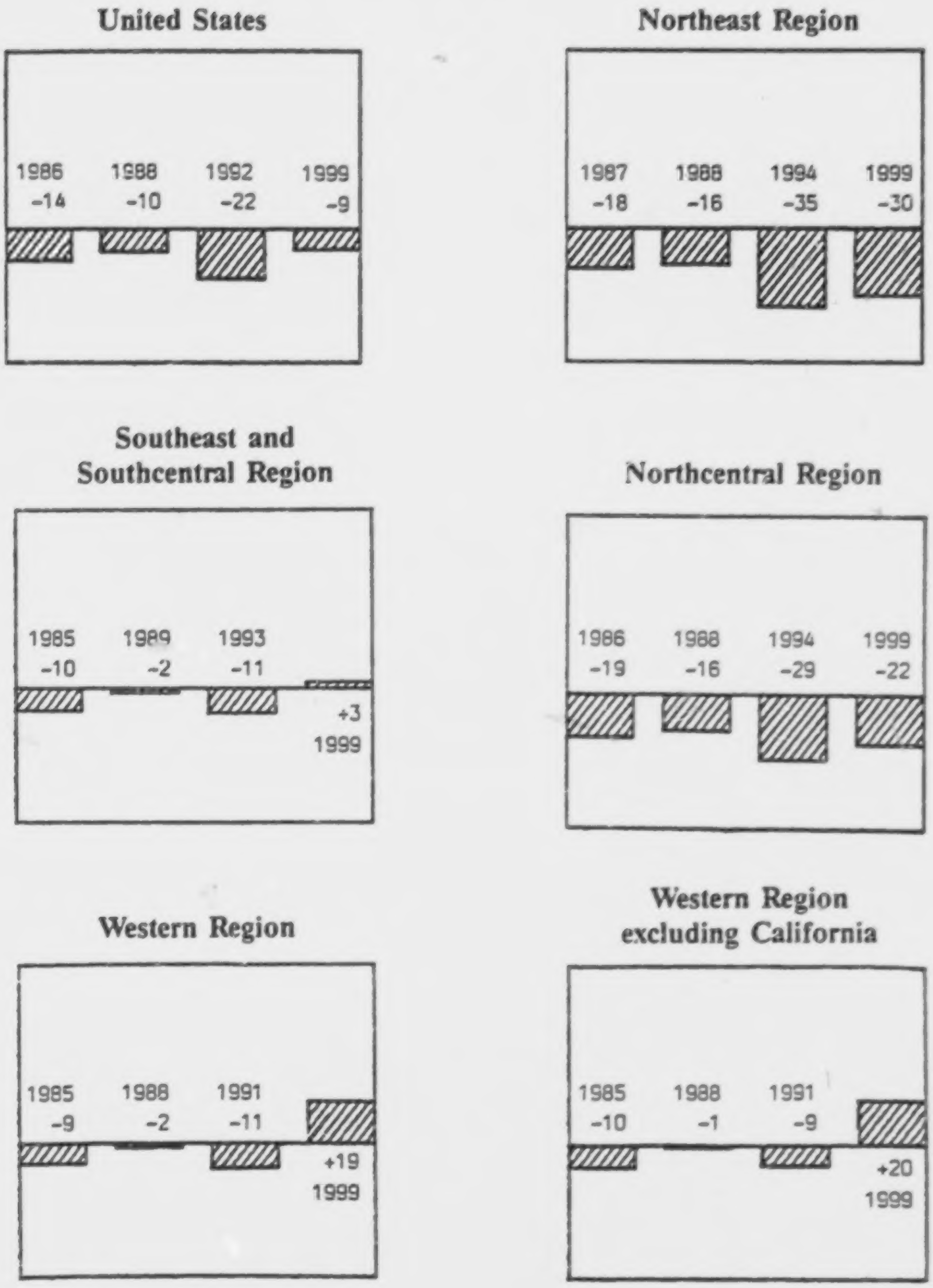
Western Region

Alaska
Arizona
California
Colorado
Hawaii
Idaho
Montana
Nevada
New Mexico
Oregon
Utah
Washington
Wyoming

Source: High School Graduates: Projections for the Fifty States (1982-2000), Western Interstate Commission for Higher Education.

Figure 1.1.8

Pattern of Projected High School Graduates
1981 - 2000
Percentage Change from 1981

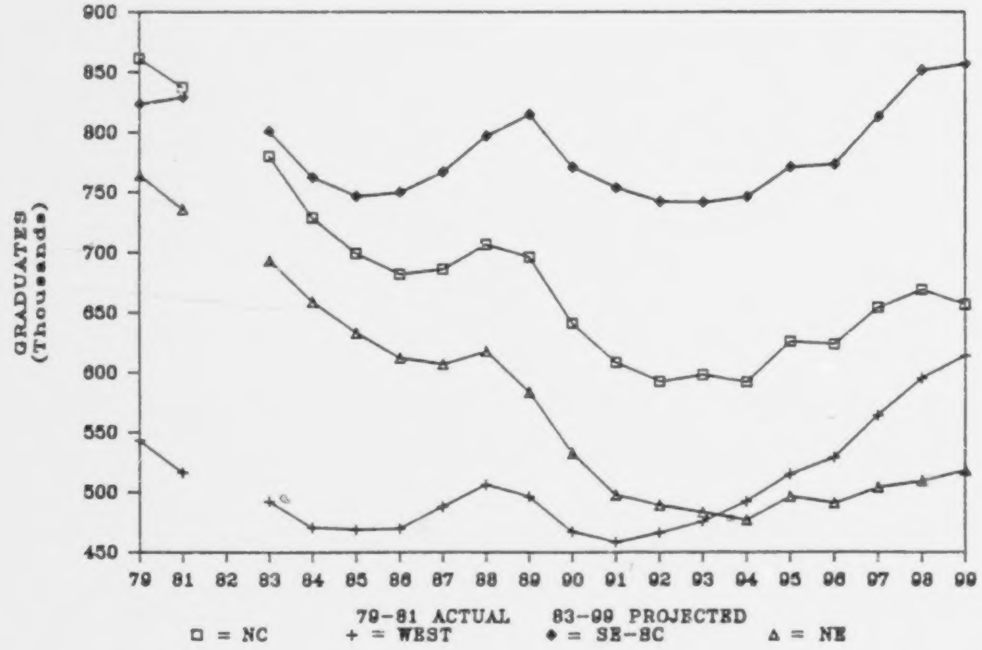


Source: High School Graduates: Projections for the fifty States (1982-2000), Western Interstate Commission for Higher Education.

Figure 1.1.9

REGIONAL PROJECTIONS

HIGH SCHOOL GRADUATES 1983-1999



Source: High School Graduates: Projections for the Fifty States (1982-2000), Western Interstate Commission for Higher Education.

Table 1.2.1

DEGREES GRANTED BY U.S. COLLEGES: Total, Chemistry, Chemical Engineering, Biochemistry

Academic Year Ending	Total - All Fields			Chemistry			Chemical Engineering			Biochemistry		
	BS	MS	PhD	BS	MS	PhD	BS	MS	PhD	BS	MS	PhD
Actual:												
1970	792,316	206,291	29,866	11,519	2,111	2,166	3,694	1,045	438	455	239	449
1971	839,730	230,509	32,107	11,063	2,275	2,159	3,579	1,100	406	568	251	517
1972	887,273	251,633	33,363	10,590	2,248	1,971	3,625	1,154	394	699	252	462
1973	972,362	263,371	34,777	10,128	2,225	1,872	3,578	1,051	397	872	270	501
1974	945,776	277,033	33,816	10,048	2,125	1,823	3,399	1,044	400	1,101	249	451
1975	922,933	292,450	34,083	10,059	1,975	1,822	3,070	990	346	1,355	268	437
1976	925,746	311,771	34,064	11,022	1,783	1,621	3,140	1,031	308	1,622	252	431
1977	919,549	317,164	33,232	11,215	1,767	1,568	3,524	1,086	291	1,693	314	447
1978	921,204	311,620	32,131	11,315	1,886	1,521	4,569	1,235	259	1,752	319	428
1979	921,390	301,079	32,730	11,509	1,757	1,516	5,568	1,149	304	1,799	301	443
1980	929,417	298,081	32,615	11,232	1,723	1,545	6,320	1,270	284	1,686	268	475
1981	935,140	295,739	32,958	11,347	1,654	1,622	6,527	1,267	300	1,837	258	460
1982	952,998	295,546	32,707	11,062	1,742	1,708	6,740	1,285	311	1,865	273	462
Projected:												
1983	970,000	295,000	32,700	11,261	1,739	1,705	7,850	1,630	390	1,899	272	461
1984	970,000	296,000	33,000	11,261	1,744	1,720	7,680	1,770	410	1,899	273	465
1985	960,000	295,000	33,200	11,148	1,739	1,731	7,600	1,760	410	1,888	272	468
1986	945,000	294,000	33,400	10,968	1,734	1,741	7,470	1,760	410	1,846	272	471
1987	935,000	292,000	33,600	10,870	1,729	1,751	7,410	1,750	420	1,829	270	474
1988	927,000	291,000	32,800	10,772	1,724	1,709	7,340	1,740	410	1,813	269	462
1989	927,000	289,000	33,100	10,772	1,712	1,725	7,350	1,730	410	1,813	267	466
1990	927,000	289,000	32,800	10,772	1,712	1,741	7,340	1,730	410	1,813	267	465
1991	922,000	287,000	33,200	10,718	1,700	1,761	7,310	1,720	410	1,804	267	459
1992	915,000	287,000	33,400	10,632	1,700	1,772	7,170	1,720	410	1,789	267	462
1993	900,000	285,000	33,600	10,462	1,688	1,782	7,050	1,700	420	1,761	265	465
1994	887,000	284,000	33,700	10,316	1,681	1,788	6,960	1,700	420	1,741	264	466

Note: Data for academic years ending 1970 through 1981 are from Earned Degrees Conferred, a series published by the National Center for Education Statistics. Data for the academic year ending 1982 are from NCES unpublished figures. Data for academic years ending 1983 through 1994 are ACS estimates based on NCES's projections of the number of degrees granted at each degree level in all fields combined. Figures are for colleges and universities in the 50 states and D.C.

Table 1.2.2

CHEMISTRY DEGREES GRANTED TO WOMEN: 1956-1983

	Bachelor's			Master's			Ph.D.		
Academic Year	Total Men & Women	Women Number	Women % of Total	Total Men & Women	Women Number	Women % of Total	Total Men & Women	Women Number	Women % of Total
1955-56	6,178	1,182	19.1	1,164	129	11.1	986	52	5.3
1956-57	6,591	1,294	19.6	1,047	134	12.8	1,003	48	4.8
1957-58	7,010	1,305	18.6	1,125	167	14.8	939	49	5.2
1958-59	7,308	1,411	19.3	1,145	164	14.3	1,009	49	4.9
1959-60	7,603	1,598	21.0	1,228	203	16.5	1,048	48	4.6
1960-61	7,604	1,508	19.8	1,313	200	15.2	1,131	57	5.0
1961-62	8,089	1,715	21.2	1,425	246	17.3	1,139	69	6.1
1962-63	8,823	1,768	20.0	1,463	259	17.7	1,254	78	6.3
1963-64	9,724	1,915	19.7	1,586	280	17.7	1,301	93	7.1
1964-65	10,047	1,936	19.3	1,715	328	19.1	1,414	101	7.1
1965-66	9,735	1,801	18.5	1,839	355	19.3	1,571	94	6.0
1966-67	9,872	1,771	17.9	1,831	347	19.0	1,744	118	6.8
1967-68	10,847	1,965	18.1	2,014	418	20.8	1,757	142	8.1
1968-69	11,807	2,156	18.3	2,070	381	18.4	1,941	145	7.5
1969-70	11,617	2,116	18.2	2,146	480	22.4	2,208	169	7.7
1970-71	11,183	2,095	18.7	2,284	492	21.5	2,160	173	8.0
1971-72	10,721	2,120	19.8	2,259	505	22.4	1,971	193	9.8
1972-73	10,226	1,967	19.2	2,230	467	20.9	1,882	184	9.8
1973-74	10,525	2,112	20.0	2,138	474	22.2	1,828	173	9.5
1974-75	10,649	2,385	22.4	2,006	416	20.7	1,824	205	11.2
1975-76	11,107	2,497	22.5	1,796	383	21.3	1,623	197	12.1
1976-77	11,322	2,602	23.0	1,775	448	25.2	1,571	188	12.0
1977-78	11,474	2,881	25.1	1,892	445	23.5	1,525	203	13.3
1978-79	11,643	3,113	26.7	1,765	447	25.3	1,518	230	15.2
1979-80	11,232	3,182	28.3	1,723	444	25.7	1,545	258	15.5
1980-81	11,347	3,394	29.1	1,654	470	28.4	1,622	251	15.5
1981-82	11,062	3,491	31.6	1,742	488	28.0	1,708	278	16.3
1982-83 (Est.)	11,261	3,716	33.0	1,739	487	28.0	1,705	288	16.9

Source: National Center for Education Statistics, Earned Degree Conferred series,

ESTIMATES OF CHEMISTRY DEGREES GRANTED TO MINORITIES: 1974-1983

Degree Level and Academic Year	Total Number of Degrees Granted (1)	Percent Granted to Minorities and Non-U.S. Citizens (2)				
		Black	American Indian	Asian/ Pacific Islander	Hispanic	Non-U.S. Citizen
Bachelor's						
1973-74	10,525	1.9	0.2	2.0	1.1	2.0
1974-75	10,649	1.4	0.1	2.0	0.9	1.8
1975-76	11,107	1.8	0.2	1.5	1.2	1.2
1976-77	11,322	1.8	0.3	2.2	1.4	1.9
1977-78	11,474	1.6	0.1	2.5	0.8	2.0
1978-79	11,643	1.6	0.2	2.4	1.3	2.3
1979-80	11,860	2.0	0.3	2.0	1.5	2.9
1980-81	11,347	2.7	0.4	2.8	1.7	2.3
1981-82	11,062	2.2	0.2	3.4	2.0	2.1
1982-83 (est)	11,261	2.7	0.1	2.6	2.1	1.8
Master's						
1973-74	2,138	2.6	0.0	1.3	0.0	13.4
1974-75	2,006	1.4	0.5	1.9	0.3	12.1
1975-76	1,796	2.7	0.0	2.1	1.1	9.9
1976-77	1,775	1.9	0.3	1.4	0.5	11.7
1977-78	1,892	3.5	0.3	1.0	0.6	12.6
1978-79	1,765	1.5	1.1	3.4	2.6	10.6
1979-80	1,820	1.3	0.6	4.5	1.3	10.3
1980-81	1,654	3.5	0.0	3.5	0.0	15.0
1981-82	1,742	4.7	0.4	2.1	0.9	7.8
1982-83 (est)	1,739	0.8	0.0	2.4	1.6	6.4
Ph.D.						
1973-74	1,828	1.2	0.2	0.8	0.8	12.7
1974-75	1,824	1.1	0.2	0.7	0.4	11.1
1975-76	1,623	0.6	0.0	2.8	0.8	12.4
1976-77	1,571	1.6	0.2	1.2	1.2	12.4
1977-78	1,525	2.8	0.3	1.8	1.0	12.2
1978-79	1,518	0.0	1.4	2.2	0.8	11.4
1979-80	1,550	0.6	0.0	2.8	0.6	10.1
1980-81	1,622	1.2	0.4	3.1	0.4	11.7
1981-82	1,708	0.6	0.0	2.5	0.6	12.0
1982-83 (3)	1,705	0.0	0.0	0.0	0.4	5.8

Source: (1) National Center for Education Statistics, Earned Degree Conferred series, and ACS estimates of degrees granted for 1979-80.
(2) ACS Starting Salary Survey series.
(3) Summary Report 1983: Doctorate Recipients, National Research Council.

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Chemistry and chemical engineering degrees awarded by approved schools, 1982–83

	CHEMISTRY				CHEMICAL ENGINEERING		
	Bachelor's, certified						
	Yes	No	M.S.	Ph.D.	B.S.	M.S.	Ph.D.
Abilene Christian U	6	2	4	—	—	—	—
Adelphi U	2	8	0	—	—	—	—
Agnes Scott C	6	0	—	—	—	—	—
Akron, U of	13	8	6	3	a	—	—
Alabama, U of							
University	4	17	2	6	42	6	2
Birmingham	4	6	2	1	—	—	—
Huntsville	3	3	2	—	—	—	—
Alaska, U of	7	1	1	—	—	—	—
Albion C	3	12	—	—	—	—	—
Albright C	8	15	—	—	—	—	—
Alfred U	9	0	—	—	—	—	—
Allegheny C	4	29	—	—	—	—	—
Alma C	2	8	—	—	—	—	—
American U	10	5	2	6	—	—	—
Amherst C	4	13	—	—	—	—	—
Andrews U	3	4	—	—	—	—	—
Appalachian State U	1	10	2	—	—	—	—
Arizona State U	28	12	0	14	43	7	0
Arizona, U of	28	6	22	24	30	6	0
Arkansas, U of							
Fayetteville	11	14	1	13	36	12	1
Little Rock	3	8	2	—	—	—	—
Ashland C	0	2	—	—	—	—	—
Auburn U	2	33	3	2	81	5	2
Augsburg C	4	3	—	—	—	—	—
Augustana C (Illinois)	1	12	—	—	—	—	—
Augustana C (South Dakota)	1	7	—	—	—	—	—
Austin C	3	8	—	—	—	—	—
Baldwin-Wallace C	1	11	—	—	—	—	—
Ball State U	5	1	5	—	—	—	—
Barnard C	5	14	—	—	—	—	—
Bates C	10	7	—	—	—	—	—
Baylor U	9	20	3	2	—	—	—
Beloit C	0	20	—	—	—	—	—
Bemidji State U	3	4	—	—	—	—	—
Birmingham-Southern C	6	24	—	—	—	—	—
Bloomsburg U	2	4	—	—	—	—	—
Boston C	10	21	3	2	—	—	—
Boston U	9	20	5	5	—	—	—
Bowdoin C	5	32	—	—	—	—	—
Bowling Green State U	6	17	5	—	—	—	—
Bradley U	3	11	0	—	—	—	—
Brandeis U	2	13	3	11	—	—	—
Bridgeport, U of	3	0	5	—	—	—	—
Bridgewater State C	2	12	0	—	—	—	—
Brigham Young U	19	28	3	4	51	8	1
Brown U	7	12	1	15	—	—	—
Bryn Mawr C	19	0	1	1	—	—	—
Bucknell U	14	12	3	—	23	3	—
Butler U	3	9	3	—	—	—	—
California Institute of Tech	7	8	6	25	13	6	5
California Polytechnic State U	9	30	0	—	—	—	—
California State C							
Bakersfield	7	2	—	—	—	—	—
San Bernardino	2	7	—	—	—	—	—
Stanislaus	1	0	—	—	—	—	—
California State Polytechnic U	7	3	4	—	45	—	—
California State U							
Chico	1	12	—	—	—	—	—
Dominguez Hills	3	4	—	—	—	—	—
Fresno	6	7	4	—	—	—	—
Fullerton	10	11	4	—	—	—	—
Hayward	8	13	1	—	—	—	—
Long Beach	9	23	18	—	46	—	—
Los Angeles	10	1	3	—	—	—	—
Northridge	8	15	4	—	—	—	—
Sacramento	8	4	8	—	—	—	—
California, U of							
Berkeley	60	4	12	58	141	23	16
Davis	37	8	6	19	59	16	3
Irvine	12	40	8	10	—	—	—
Los Angeles	44	65	11	28	—	—	—
Riverside	19	2	11	11	—	—	—
San Diego	59	0	18	28	—	—	—
Santa Barbara	24	9	6	13	35	5	2
Santa Cruz	30	15	5	6	—	—	—
Calvin C	5	5	—	—	—	—	—
Canisius C	7	8	—	—	—	—	—
Capital U	0	4	—	—	—	—	—
Carleton C	2	30	—	—	—	—	—
Carnegie-Mellon U	27	0	8	4	77	11	10
Carroll C	2	7	—	—	—	—	—
Carthage C	1	4	—	—	—	—	—
Case Western Reserve U	9	36	8	10	40	8	2
Catholic U of America	1	1	0	2	a	—	—
Centenary C of Louisiana	0	5	—	—	—	—	—
Central C	0	9	—	—	—	—	—
Central Connecticut State U	3	0	3	—	—	—	—
Central Florida, U of	12	0	3	—	—	—	—
Central Michigan U	3	14	10	—	—	—	—
Central State U (Ohio)	2	1	—	—	—	—	—
Central State U (Oklahoma)	1	15	—	—	—	—	—
Charleston, C of	10	5	—	—	—	—	—
Chatham C	1	1	—	—	—	—	—
Chestnut Hill C	5	4	—	—	—	—	—
Chicago, U of	4	26	3	23	—	—	—
Cincinnati, U of	19	0	17	24	58	9	1
Citadel, The	0	12	—	—	—	—	—
City U of New York							
Graduate Center	—	—	—	12	—	—	—
Brooklyn C	0	34	0	—	—	—	—
City C	1	12	3	—	a	—	—
Herbert H. Lehman C	2	7	—	—	—	—	—
Hunter C	2	5	—	—	—	—	—
Queens C	2	17	4	—	—	—	—
Clarion U of Pennsylvania	3	3	—	—	—	—	—
Clark U	15	3	1	1	—	—	—
Clarkson C of Tech	16	0	1	4	114	9	4
Clemson U	5	4	2	3	65	11	0
Cleveland State U	14	0	7	6	46	2	3
Coe C	1	8	—	—	—	—	—
Colby C	5	13	—	—	—	—	—
Colgate U	4	7	—	—	—	—	—
Colorado C	9	2	—	—	—	—	—
Colorado School of Mines	7	0	9	5	90	6	1
Colorado State U	11	8	2	13	23	4	0
Colorado, U of							
Boulder	25	39	4	21	72	9	2
Denver	2	12	1	—	—	—	—
Columbia U	9	0	17	20	42	36	6
Concordia C	1	10	—	—	—	—	—
Connecticut, U of	12	24	6	1	59	6	2
Cooper Union[b]	—	—	—	—	25	1	—
Cornell C	0	11	—	—	—	—	—
Cornell U	27	26	45	23	78	23	6
Creighton U	5	39	4	—	—	—	—
Dartmouth C	0	24	0	6	—	—	—
David Lipscomb C	0	15	—	—	—	—	—
Davidson C	9	4	—	—	—	—	—
Dayton, U of	11	3	1	—	32	5	—
Delaware State C	2	1	—	—	—	—	—
Delaware, U of	35	17	4	7	77	10	8
Delaware Valley C of Science & Agriculture	5	0	—	—	—	—	—
Delta State U	1	6	—	—	—	—	—
Denison U	3	5	—	—	—	—	—
Denver, U of	6	7	2	0	—	—	—

	CHEMISTRY				CHEMICAL ENGINEERING		
	Bachelor's, certified						
	Yes	No	M.S.	Ph.D.	B.S.	M.S.	Ph.D.
DePaul U	0	0	5	—	—	—	—
DePauw U	4	8	—	—	—	—	—
Detroit, U of	6	4	3	1	a	—	—
Dickinson C	4	10	—	—	—	—	—
Drake U	4	7	—	—	—	—	—
Drew U	1	7	—	—	—	—	—
Drexel U	14	0	9	4	75	4	1
Duke U	16	60	1	13	—	—	—
Duquesne U	0	2	11	3	—	—	—
Earlham C	3	7	—	—	—	—	—
East Carolina U	6	9	0	—	—	—	—
East Stroudsburg State U	7	15	0	—	—	—	—
East Tennessee State U	6	9	2	—	—	—	—
East Texas State U	3	2	10	—	—	—	—
Eastern Illinois U	6	3	6	—	—	—	—
Eastern Kentucky U	4	13	1	—	—	—	—
Eastern Michigan U	4	26	7	—	—	—	—
Elizabethtown C	0	13	—	—	—	—	—
Elmhurst C	3	15	—	—	—	—	—
Emory U	9	97	11	3	—	—	—
Emporia State U	5	3	2	—	—	—	—
Evansville, U of	3	3	—	—	—	—	—
Fairfield U	6	4	—	—	—	—	—
Fairleigh Dickinson U							
Madison	2	10	7	—	—	—	—
Rutherford	2	0	2	—	—	—	—
Teaneck	6	0	4	—	—	—	—
Fisk U	11	0	4	—	—	—	—
Florida Atlantic U	8	28	3	1	—	—	—
Florida Institute of Tech	1	0	0	—	—	—	—
Florida State U	12	22	4	11	—	—	—
Florida, U of	13	58	12	27	90	10	4
Fordham U	0	14	5	1	—	—	—
Fort Lewis C	2	6	—	—	—	—	—
Franklin & Marshall C	11	8	—	—	—	—	—
Furman U	18	0	3	—	—	—	—
Geneva C	0	3	—	—	—	—	—
George Mason U	9	7	—	—	—	—	—
George Washington U	4	13	1	1	—	—	—
Georgetown U	19	0	11	6	—	—	—
Georgia Institute of Tech	20	0	7	5	155	20	1
Georgia State U	2	1	6	—	—	—	—
Georgia, U of	8	55	12	15	—	—	—
Gettysburg C	2	5	—	—	—	—	—
Glassboro State C	13	4	—	—	—	—	—
Gonzaga U	3	4	—	—	—	—	—
Goucher C	2	12	—	—	—	—	—
Grand Valley State C	0	9	—	—	—	—	—
Grinnell C	2	17	—	—	—	—	—
Gustavus Adolphus C	8	11	—	—	—	—	—
Hamilton C	0	10	—	—	—	—	—
Hamline U	7	1	—	—	—	—	—
Hampden-Sydney C	5	7	—	—	—	—	—
Hampton Institute	5	2	1	—	—	—	—
Hartford, U of	2	6	0	—	—	—	—
Hartwick C	4	1	—	—	—	—	—
Harvard U	0	26	9	27	—	—	—
Harvey Mudd C	13	0	—	—	—	—	—
Haverford C	3	11	—	—	—	—	—
Hawaii, U of	16	4	2	1	—	—	—
Hiram C	10	6	—	—	—	—	—
Hobart & William Smith C	2	12	—	—	—	—	—
Hofstra U	10	2	—	—	—	—	—
Hollins C	0	1	—	—	—	—	—
Holy Cross, C of the	29	16	—	—	—	—	—
Hope C	15	28	—	—	—	—	—
Houston, U of	19	2	7	13	47	47	9
Howard U	3	28	5	6	18	—	—
Humboldt State U	4	4	—	—	—	—	—

	CHEMISTRY				CHEMICAL ENGINEERING		
	Bachelor's, certified						
	Yes	No	M.S.	Ph.D.	B.S.	M.S.	Ph.D.
Idaho State U	5	2	0	—	—	—	—
Idaho, U of	6	6	2	6	13	14	0
Illinois Benedictine C	8	0	—	—	—	—	—
Illinois Institute of Tech	4	0	5	2	a	—	—
Illinois State U	41	1	3	—	—	—	—
Illinois, U of							
Chicago	13	22	26	5	65	9	0
Urbana-Champaign	51	62	18	66	125	24	13
Illinois Wesleyan U	0	5	—	—	—	—	—
Indiana State U	12	1	1	—	—	—	—
Indiana U							
Bloomington	28	92	12	29	—	—	—
South Bend	2	4	—	—	—	—	—
Indiana U of Pennsylvania	9	3	4	—	—	—	—
Indiana U-Purdue U							
Fort Wayne	2	3	—	—	—	—	—
Indianapolis	3	17	7	—	—	—	—
Iowa State U	12	1	5	22	58	6	4
Iowa, U of	8	2	5	4	19	7	1
Ithaca C	4	6	—	—	—	—	—
Jackson State U	6	3	0	—	—	—	—
James Madison U	1	16	—	—	—	—	—
John Carroll U	8	22	0	—	—	—	—
Johns Hopkins U	16	0	10	9	—	—	—
Juniata C	2	16	—	—	—	—	—
Kalamazoo C	5	17	—	—	—	—	—
Kansas State U	5	5	5	8	36	4	3
Kansas, U of	8	18	2	7	49	5	4
Kean C of New Jersey	2	16	—	—	—	—	—
Kearney State C	1	5	—	—	—	—	—
Kent State U	7	13	1	8	—	—	—
Kentucky, U of	4	13	7	6	51	5	2
Kenyon C	12	5	—	—	—	—	—
King's C	3	4	—	—	—	—	—
Knox C	4	22	—	—	—	—	—
Lafayette C	11	9	—	—	37	—	—
Lake Forest C	1	8	—	—	—	—	—
Lamar U	6	1	2	—	32	4	0
LaSalle C	10	6	—	—	—	—	—
Lawrence Institute of Tech	11	0	—	—	—	—	—
Lawrence U[c]	3	8	11	2	—	—	—
Lebanon Valley C	4	1	—	—	—	—	—
Lehigh U	19	0	4	8	85	25	3
LeMoyne C	4	0	—	—	—	—	—
Lincoln U	0	8	—	—	—	—	—
Long Island U							
Brooklyn Center	3	3	5	—	—	—	—
C. W. Post C	8	4	—	—	—	—	—
Loras C	3	5	—	—	—	—	—
Louisiana State U							
Baton Rouge	6	3	2	11	81	6	6
Shreveport	4	0	—	—	—	—	—
Louisiana Tech U	0	3	4	—	28	3	1
Louisville, U of	7	19	1	1	28	18	0
Lowell, U of	9	2	3	3	47	3	—
Loyola C	5	1	—	—	—	—	—
Loyola Marymount U	4	1	—	—	—	—	—
Loyola U in New Orleans	3	1	—	—	—	—	—
Loyola U of Chicago	11	14	2	2	—	—	—
Luther C	0	9	—	—	—	—	—
Macalester C	3	9	—	—	—	—	—
MacMurray C	0	2	—	—	—	—	—
Maine, U of	6	1	6	2	31	6	0
Manhattan C[d]	4	1	—	—	56	23	—
Manhattanville C	2	0	—	—	—	—	—
Mankato State U	7	9	0	—	—	—	—
Marietta C	2	1	—	—	—	—	—
Marist C	0	4	—	—	—	—	—
Marquette U	12	3	5	3	—	—	—

	CHEMISTRY				CHEMICAL ENGINEERING		
	Bachelor's, certified						
	Yes	No	M.S.	Ph.D.	B.S.	M.S.	Ph.D.
Marshall U	5	19	3	—	—	—	—
Maryland, U of							
Baltimore County	6	16	0	0	—	—	—
College Park	19	70	10	21	68	11	0
Massachusetts Institute of Tech	39	0	3	41	96	66	13
Massachusetts, U of	16	3	10	22	60	7	4
McMurry C	1	5	—	—	—	—	—
McNeese State U	4	3	1	—	—	—	—
Memphis State U	2	7	3	0	—	—	—
Mercer U	10	3	—	—	—	—	—
Merrimack C	11	0	—	—	—	—	—
Metropolitan State C	14	18	—	—	—	—	—
Miami U	30	37	3	6	—	—	—
Miami, U of	5	91	1	0	—	—	—
Michigan State U	27	15	13	33	76	11	4
Michigan Tech U	14	0	2	2	97	9	0
Michigan, U of							
Ann Arbor	75	0	20	17	124	38	6
Dearborn	10	11	—	—	—	—	—
Flint	2	7	—	—	—	—	—
Middle Tennessee State U	2	18	6	—	—	—	—
Middlebury C	1	7	0	—	—	—	—
Midwestern State U	2	6	—	—	—	—	—
Millersville U of Pennsylvania	5	4	—	—	—	—	—
Millsaps C	2	14	—	—	—	—	—
Minnesota, U of							
Duluth	14	9	6	—	—	—	—
Minneapolis	23	0	7	12	169	19	16
Mississippi C	0	11	—	—	—	—	—
Mississippi State U	2	2	0	0	65	4	0
Mississippi, U of	1	27	2	6	25	0	1
Missouri, U of							
Columbia	6	8	11	4	55	3	1
Kansas City	7	11	0	2	—	—	—
Rolla	9	0	6	3	74	18	4
St. Louis	11	12	4	0	—	—	—
Missouri Western State C	0	5	—	—	—	—	—
Monmouth C	1	6	—	—	—	—	—
Montana C of Mineral Science & Tech	1	1	3	—	—	—	—
Montana State U	6	9	3	11	60	9	2
Montana, U of	7	5	4	1	—	—	—
Montclair State C	2	18	6	—	—	—	—
Moorhead State U	3	4	—	—	—	—	—
Moravian C	3	3	—	—	—	—	—
Morehouse C[e]	3	0	6	1	—	—	—
Morgan State U	3	6	—	—	—	—	—
Mount Holyoke C	0	19	2	0	—	—	—
Mount Saint Vincent, C of[d]	1	2	—	—	—	—	—
Muhlenberg C	3	17	—	—	—	—	—
Murray State U	5	14	6	—	—	—	—
Muskingum C	3	5	—	—	—	—	—
Nebraska, U of							
Lincoln	9	6	6	23	a	—	—
Omaha	8	3	—	—	—	—	—
Nebraska Wesleyan U	2	1	—	—	—	—	—
Nevada, U of							
Las Vegas	2	4	—	—	—	—	—
Reno	1	6	0	3	—	—	—
New Hampshire, U of	5	7	4	5	31	4	1
New Jersey Institute of Tech[b]	—	—	—	—	98	21	4
New Mexico Highlands U	0	2	1	—	—	—	—
New Mexico Institute of Tech	6	0	4	—	—	—	—
New Mexico State U	6	10	3	7	38	5	—
New Mexico, U of	11	7	6	8	35	8	4
New Orleans, U of	2	15	3	5	—	—	—
New York U	9	30	16	14	—	—	—
Niagara U	1	9	—	—	—	—	—
North Alabama, U of	3	12	—	—	—	—	—
North Carolina A&T State U	5	0	5	—	—	—	—
North Carolina Central U	0	3	2	—	—	—	—
North Carolina State U	14	9	5	9	108	10	2
North Carolina, U of							
Asheville	3	2	—	—	—	—	—
Chapel Hill	40	96	8	32	—	—	—
Charlotte	6	4	2	—	—	—	—
Greensboro	10	6	3	—	—	—	—
Wilmington	0	14	—	—	—	—	—
North Dakota State U	1	12	3	4	24	4	—
North Dakota, U of	0	2	1	1	—	—	—
North Texas State U	5	10	10	5	—	—	—
Northeast Louisiana U	4	0	2	—	—	—	—
Northeastern U	5	0	9	4	36	16	0
Northern Arizona U	9	37	0	—	—	—	—
Northern Colorado, U of	0	7	2	1	—	—	—
Northern Illinois U	10	11	9	8	—	—	—
Northern Iowa, U of	6	15	0	—	—	—	—
Northern Kentucky U	1	6	—	—	—	—	—
Northern Michigan U	2	14	1	—	—	—	—
Northwest Missouri State U	5	1	—	—	—	—	—
Northwestern State U of Louisiana	0	4	—	—	—	—	—
Northwestern U	20	14	26	19	51	18	7
Norwich U	0	0	—	—	—	—	—
Notre Dame, U of	8	16	8	11	76	9	2
Oakland U	9	5	0	—	—	—	—
Oberlin C	1	22	—	—	—	—	—
Occidental C	3	17	—	—	—	—	—
Ohio Northern U	3	10	—	—	—	—	—
Ohio State U	27	0	11	27	83	12	6
Ohio U	13	5	3	5	20	11	0
Ohio Wesleyan U	3	14	—	—	—	—	—
Oklahoma State U	4	5	3	7	62	20	10
Oklahoma, U of	12	17	5	3	63	11	1
Old Dominion U	3	4	7	—	—	—	—
Oregon State U	8	0	5	5	45	16	1
Oregon, U of	7	32	3	7	—	—	—
Pace U	0	5	—	—	—	—	—
Pacific Lutheran U	4	6	—	—	—	—	—
Pacific, U of the	2	11	2	1	—	—	—
Pennsylvania State U	2	5	6	23	216	23	2
Pennsylvania, U of	8	28	4	17	55	9	7
Philadelphia C of Pharmacy & Science	4	0	0	0	—	—	—
Philadelphia C of Textiles & Science	5	0	—	—	—	—	—
Pittsburg State U	7	2	0	—	—	—	—
Pittsburgh, U of	19	76	15	13	105	30	7
Polytechnic Institute of New York	10	1	5	9	38	24	3
Pomona C	8	3	—	—	—	—	—
Portland State U	1	10	3	4	—	—	—
Pratt Institute[b]	—	—	—	—	9	—	—
Princeton U	11	9	33	14	51	2	11
Providence U	7	1	0	0	—	—	—
Puerto Rico, U of							
Mayaguez	13	11	2	—	61	2	0
Rio Piedras	25	34	2	2	—	—	—
Puget Sound, U of	5	0	—	—	—	—	—
Purdue U	29	21	9	34	146	18	[illegible]
Purdue U Calumet	1	2	—	—	—	—	—
Randolph-Macon Woman's C	2	5	—	—	—	—	—
Redlands, U of	0	1	—	—	—	—	—
Reed C	15	2	—	—	—	—	—
Regis C	1	5	—	—	—	—	—
Rensselaer Polytechnic Institute	34	0	11	6	104	14	4
Rhode Island, U of	6	2	2	5	26	4	0
Rice U	12	2	1	15	37	11	3
Richmond, U of	1	15	1	—	—	—	—
Rider C	4	0	—	—	—	—	—
Ripon C	2	4	—	—	—	—	—
Roanoke C	1	4	—	—	—	—	—
Rochester Institute of Tech	9	4	3	—	—	—	—

	CHEMISTRY				CHEMICAL ENGINEERING		
	Bachelor's, certified						
	Yes	No	M.S.	Ph.D.	B.S.	M.S.	Ph.D.
Rochester, U of	5	6	26	14	57	15	4
Rollins C	4	0	—	—	—	—	—
Roosevelt U	8	1	4	—	—	—	—
Rose-Hulman Institute of Tech	11	0	—	—	53	2	—
Russell Sage C	3	2	—	—	—	—	—
Rutgers U							
Camden C	8	7	—	—	—	—	—
New Brunswick	46	12	7	10	108	19	2
Newark C of Arts & Sciences	10	13	7	9	—	—	—
Saginaw Valley State C	2	9	—	—	—	—	—
St. Anselm C	1	4	—	—	—	—	—
St. Cloud State U	1	4	—	—	—	—	—
St. John Fisher C	12	0	—	—	—	—	—
St. John's U	8	3	3	—	—	—	—
St. Joseph C	2	1	1	—	—	—	—
St. Joseph's U	8	13	6	—	—	—	—
St. Lawrence U	11	19	—	—	—	—	—
St. Louis U	9	36	5	—	—	—	—
St. Mary's C	5	9	—	—	—	—	—
St. Michael's C	0	4	—	—	—	—	—
St. Olaf C	6	31	—	—	—	—	—
St. Peter's C	0	3	—	—	—	—	—
St. Thomas, C of	2	4	—	—	—	—	—
Salem State C	4	0	—	—	—	—	—
Sam Houston State U	11	0	4	—	—	—	—
San Diego State U	17	3	8	1	—	—	—
San Francisco State U	6	28	7	—	—	—	—
San Francisco, U of	5	5	5	—	—	—	—
San Jose State U	20	14	11	—	17	10	—
Santa Clara, U of	3	4	—	—	—	—	—
Scranton, U of	8	11	21	—	—	—	—
Seattle U	2	6	—	—	—	—	—
Seton Hall U	8	1	13	8	—	—	—
Shippensburg U	11	8	4	—	—	—	—
Siena C	12	0	—	—	—	—	—
Simmons C	8	1	—	—	—	—	—
Skidmore C	3	21	—	—	—	—	—
Slippery Rock State C	0	3	—	—	—	—	—
Smith C	2	4	0	0	—	—	—
Sonoma State U	0	13	—	—	—	—	—
South Carolina, U of	7	21	5	13	35	6	2
South Dakota School of Mines & Tech	12	2	5	—	29	5	—
South Dakota State U	0	28	3	—	—	—	—
South Dakota, U of	3	15	2	—	—	—	—
South Florida, U of	16	58	1	0	35	3	0
Southeast Missouri State U	0	6	—	—	—	—	—
Southeastern Louisiana U[f]	—	—	—	—	—	—	—
Southeastern Massachusetts U	6	2	1	—	—	—	—
Southern California, U of	17	7	2	20	32	11	0
Southern Colorado, U of[f]	—	—	—	—	—	—	—
Southern Illinois U							
Carbondale	1	17	2	6	—	—	—
Edwardsville	11	7	4	—	—	—	—
Southern Methodist U	7	18	2	—	—	—	—
Southern Mississippi, U of	2	17	4	3	—	—	—
Southern Oregon State C	0	4	—	—	—	—	—
Southern U & A&M C	6	0	1	—	—	—	—
Southwest Missouri State U	1	12	—	—	—	—	—
Southwest State U	1	8	—	—	—	—	—
Southwest Texas State U	20	3	4	—	—	—	—
Southwestern at Memphis	3	4	—	—	—	—	—
Southwestern Louisiana, U of	1	8	1	—	11	7	—
Southwestern Oklahoma State U	4	7	—	—	—	—	—
Stanford U	9	12	2	17	19	22	8

	CHEMISTRY				CHEMICAL ENGINEERING		
	Bachelor's, certified						
	Yes	No	M.S.	Ph.D.	B.S.	M.S.	Ph.D.
State U of New York							
Albany	25	3	3	2	—	—	—
Binghamton	4	36	1	5	—	—	—
Buffalo	9	13	6	12	78	9	3
Stony Brook	14	43	6	15	—	—	—
C at Brockport	5	1	—	—	—	—	—
C at Buffalo	6	6	2	—	—	—	—
C at Cortland	2	5	—	—	—	—	—
C at Fredonia	11	14	2	—	—	—	—
C at Geneseo	6	0	0	—	—	—	—
C at New Paltz	13	1	1	—	—	—	—
C at Oneonta	2	19	0	—	—	—	—
C at Oswego	12	0	0	—	—	—	—
C at Plattsburgh	6	14	0	—	—	—	—
C at Potsdam	3	19	—	—	—	—	—
Stephen F. Austin State U	5	12	2	—	—	—	—
Stetson U	2	3	—	—	—	—	—
Stevens Institute of Tech	8	0	14	3	—	—	—
Suffolk U	3	5	—	—	—	—	—
Susquehanna U	1	5	—	—	—	—	—
Swarthmore C	6	8	—	—	—	—	—
Syracuse U	23	7	4	4	22	5	0
Temple U	8	6	7	4	—	—	—
Tennessee Technological U	4	10	3	—	47	9	—
Tennessee, U of							
Chattanooga	10	19	—	—	—	—	—
Knoxville	5	13	4	8	73	11	5
Martin	5	5	—	—	—	—	—
Texas A&I U	2	0	2	—	21	9	—
Texas A&M U	30	13	4	29	158	10	1
Texas Christian U	1	10	2	4	—	—	—
Texas Southern U	21	0	7	—	—	—	—
Texas Tech U	16	9	4	4	41	9	1
Texas, U of							
Arlington	12	9	7	0	—	—	—
Austin	57	0	3	24	101	39	6
Dallas	6	2	0	—	—	—	—
El Paso	14	1	9	—	—	—	—
Texas Woman's U	2	4	0	2	—	—	—
Thiel C	1	5	—	—	—	—	—
Thomas More C	6	0	—	—	—	—	—
Toledo, U of	3	20	3	1	20	6	1
Towson State U	2	5	—	—	—	—	—
Trenton State C	11	0	—	—	—	—	—
Trinity C	9	9	0	—	—	—	—
Trinity U	0	4	0	—	—	—	—
Tri-State U[b]	—	—	—	—	a	—	—
Tufts U	0	26	4	0	37	4	1
Tulane U of Louisiana	2	10	1	2	28	5	0
Tulsa, U of	1	0	—	—	a	—	—
Tuskegee Institute	0	4	1	—	—	—	—
Union C	6	12	0	—	—	—	—
U.S. Air Force Academy	6	4	—	—	—	—	—
U.S. Naval Academy	17	0	—	—	—	—	—
Ursinus C	9	16	—	—	—	—	—
Utah State U	5	0	0	8	—	—	—
Utah, U of	4	25	3	9	a	—	—
Valparaiso U	4	38	—	—	—	—	—
Vanderbilt U	3	22	2	9	31	4	1
Vassar C	2	2	0	—	—	—	—
Vermont, U of	27	0	5	3	—	—	—
Villanova U	9	0	14	7	38	6	—
Virginia Commonwealth U	14	38	3	2	—	—	—
Virginia Military Institute	13	0	—	—	—	—	—
Virginia Polytechnic Institute & State U	14	14	10	6	79	5	3

	CHEMISTRY				CHEMICAL ENGINEERING		
	Bachelor's, certified						
	Yes	No	M.S.	Ph.D.	B.S.	M.S.	Ph.D.
Virginia, U of	3	69	4	4	49	28	3
Wabash C	7	11	—	—	—	—	—
Wagner C	0	7	—	—	—	—	—
Wake Forest U	3	9	0	0	—	—	—
Washburn U of Topeka	1	2	—	—	—	—	—
Washington C	2	0	—	—	—	—	—
Washington and Jefferson C	2	27	—	—	—	—	—
Washington and Lee U	1	6	—	—	—	—	—
Washington State U	8	8	11	8	21	6	0
Washington U	9	7	4	3	40	3	6
Washington, U of	59	18	17	14	58	6	7
Wayne State U	20	23	7	9	50	19	5
Waynesburg C	0	0	—	—	—	—	—
Weber State C	3	7	—	—	—	—	—
Wellesley C	1	18	—	—	—	—	—
Wesleyan U	4	15	0	7	—	—	—
West Chester U	5	14	2	—	—	—	—
West Florida, U of	16	2	—	—	—	—	—
West Texas State U	0	13	2	—	—	—	—
West Virginia Institute of Tech	3	0	—	—	25	0	—
West Virginia State C	2	4	—	—	—	—	—
West Virginia U	9	38	1	3	43	9	0
Western Illinois U	4	5	1	—	—	—	—
Western Kentucky U	5	8	4	—	—	—	—
Western Maryland C	3	11	—	—	—	—	—
Western Michigan U	4	20	0	4	—	—	—
Western New England C	2	2	—	—	—	—	—
Western Washington U	13	12	6	—	—	—	—
Westminster C	0	8	—	—	—	—	—
Wheaton C (Illinois)	5	15	—	—	—	—	—
Wheaton C (Massachusetts)	1	6	—	—	—	—	—
Wheeling C	0	1	—	—	—	—	—
Whitman C	3	5	—	—	—	—	—
Whittier C	3	3	—	—	—	—	—
Wichita State U	9	3	6	0	—	—	—
Widener U	3	0	—	—	—	—	—
Wilkes C	7	4	—	—	—	—	—
Willamette U	2	7	—	—	—	—	—
William Paterson C of New Jersey	0	6	—	—	—	—	—
William and Mary, C of	32	2	2	—	—	—	—
Williams C	4	17	—	—	—	—	—
Wisconsin, U of							
Eau Claire	3	10	—	—	—	—	—
Green Bay	0	10	—	—	—	—	—
La Crosse	2	11	—	—	—	—	—
Madison	12	14	4	37	120	13	11
Milwaukee	2	13	3	2	—	—	—
Oshkosh	10	3	0	—	—	—	—
Parkside	1	5	—	—	—	—	—
Platteville	0	2	—	—	—	—	—
River Falls	11	6	—	—	—	—	—
Stevens Point	9	7	—	—	—	—	—
Superior	0	3	—	—	—	—	—
Wittenberg U	2	6	—	—	—	—	—
Wooster, C of	5	25	—	—	—	—	—
Worcester Polytechnic Institute	3	6	2	2	48	7	2
Wright State U	16	20	14	—	—	—	—
Wyoming, U of	1	5	6	4	18	6	0
Xavier U	9	9	2	—	—	—	—
Xavier U of Louisiana	1	17	—	—	—	—	—
Yale U	10	0	26	26	—	—	—
Youngstown State U	6	50	5	—	23	—	—
TOTALS	4233	5810	1569	1759	7021	1317	333

a Data not submitted. b Listed on basis of accreditation by AIChE-ABET. c Master's and Ph.D. degrees given by the Institute of Paper Chemistry. d The chemistry programs at Mount Saint Vincent and Manhattan College are integrated into a combined department with all instruction in chemistry located at Manhattan College. e Master's degrees given by Atlanta University. f Added in 1983. Note: For brevity, "B.S." and "M.S." are used to denote all bachelor's and master's degrees, respectively, in each column.

Source: Committee on Professional Training, American Chemical Society

Reprinted from Chemical and Engineering News, 1984

Table 1.3.1

ACS MEMBER'S RATINGS OF FOUR CORE UNDERGRADUATE COURSES

	In current undergraduate curricula, this area is		
	Very important	Somewhat important	Not very important
CHEMISTRY			
Organic chemistry	88%	11%	1%
Analytical chemistry	82	16	2
Physical chemistry	74	22	4
Inorganic chemistry	73	24	3
Biochemistry	41	48	11
Polymer chemistry	31	52	17
Health and safety chemistry	31	51	18
Industrial chemistry	31	50	19
Chemical engineering	28	51	21
Surface chemistry and catalysis	22	57	21
Toxicology	17	52	31
Geochemistry	5	38	57

	In current undergraduate curricula, this area is		
	Very important	Somewhat important	Not very important
OTHER AREAS			
Writing and public speaking	73	25	2
Computer science	70	28	2
Calculus, linear algebra, and statistics	62	34	4
Information retrieval for chemists	55	39	6
Physics	44	45	11
Biology and other life sciences	33	54	13
Business and management	25	53	22
Foreign languages	19	49	32
Humanities	14	50	36
Social sciences	11	51	38

Source: American Chemical Society

	How useful was your undergraduate work in this area?			
	Very useful	Somewhat useful	Little use	Did no work
CHEMISTRY				
Organic chemistry	73%	22%	4%	1%
Analytical chemistry	69	23	6	2
Physical chemistry	54	31	12	3
Inorganic chemistry	54	33	10	3
Biochemistry	23	21	16	40
Polymer chemistry	13	13	12	62
Chemical engineering	14	11	7	68
Industrial chemistry	11	14	9	66
Health and safety chemistry	7	14	9	70
Surface chemistry and catalysis	9	15	14	62
Toxicology	5	9	9	77
Geochemistry	2	6	10	82

	How useful was your undergraduate work in this area?			
	Very useful	Somewhat useful	Little use	Did no work
OTHER AREAS				
Writing and public speaking	52	28	7	13
Calculus, linear algebra, and statistics	45	41	13	1
Information retrieval for chemists	32	29	11	28
Physics	30	41	25	4
Computer science	26	19	8	47
Biology and other life sciences	23	29	17	31
Foreign languages	16	37	36	11
Humanities	12	37	37	14
Business and management	11	18	13	58
Social sciences	8	33	37	22

Source: American Chemical Society

Source: Salary Survey 1984. American Chemical Society

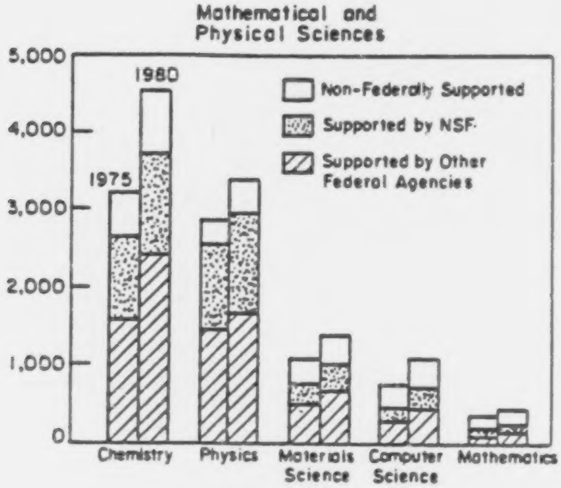
Table 1.3.2

POST-GRADUATION PLANS OF CHEMISTRY AND CHEMICAL ENGINEERING B.S. GRADUATES: 1973-1984

Academic Year Ending	Total (1) Graduates	% Planning Full-time Study	% Full-time Employed (2)		
			Total	In Chem.	Not in Chem.
Chemistry:					
1973	10,128	na	35.7	25.2	10.5
1974	10,048	na	31.8	24.5	7.3
1975	10,059	na	29.5	22.6	6.9
1976	11,022	na	27.6	19.7	7.9
1977	11,215	60.5	30.2	22.3	7.9
1978	11,315	58.3	34.4	25.7	9.4
1979	11,509	54.7	36.8	27.7	9.1
1980	11,232	57.9	34.6	26.1	8.5
1981	11,347	55.1	36.0	27.0	9.0
1982	11,062	56.1	32.7	24.0	8.7
1983	11,223	54.8	32.7	23.5	9.2
1984	11,900 (NCES est)	54.6	33.6	25.3	8.3
Chemical Engineering:					
1973	3,578	na	69.0	61.9	7.1
1974	3,399	na	69.4	73.0	3.6
1975	3,070	na	71.1	65.4	5.7
1976	3,140	na	75.5	71.4	4.1
1977	3,524	20.0	76.5	72.1	4.4
1978	4,569	20.0	74.8	68.8	6.0
1979	5,568	17.3	79.5	71.6	7.9
1980	6,320	15.3	79.1	71.4	7.7
1981	6,527	14.3	79.2	69.2	10.4
1982	6,740	16.2	63.1	52.2	10.9
1983	7,845	21.4	46.7	35.2	11.5
1984	8,230	19.1	61.9	49.1	12.8

SOURCE:
(1) National Center for Education Statistics, Earned Degrees Conferred series.
(2) ACS Starting Salary series.

GRADUATES STUDENTS WITH RESEARCH ASSISTANTSHIPS ENROLLED FULL-TIME IN DOCTORATE GRANTING INSTITUTIONS



Source: National Science Foundation
Status of Science Reviews, 1983

Reprinted from American Mathematical Society News, November 1984

Table 1.4.2

Sources of Support in Graduate School of Doctorate Recipients by Sex and Summary Field, 1983

Sources of Support in Graduate School		Total	Field of Doctorate Physical Sciences[1]	Engineering	Life Sciences	Social Sciences	Humanities	Prof. Fields	Education
		Men/Women	Men/Women	Men/Women	Men/Women	Men/Women	Men/Women	Men/Women	Men/Women
NSF Fellowship	N	516/ 183	219/ 27	97/ 9	94/ 64	74/ 61	10/ 10	8/ 0	14/ 12
	V%[2]	2.6/ 1.8	6.1/ 4.5	3.9/ 7.7	2.6/ 3.9	2.2/ 2.7	.5/ .7	.7/ .0	.4/ .4
	H%	100.0/100.0	42.4/ 14.8	18.8/ 4.9	18.2/ 35.0	14.3/ 33.3	1.9/ 5.5	1.6/ .0	2.7/ 6.6
NSF Traineeship	N	90/ 48	25/ 10	15/ 0	32/ 17	17/ 16	0/ 2	0/ 0	1/ 3
	V%	.5/ .5	.7/ 1.7	.6/ .0	.9/ 1.0	.5/ .7	.0/ .1	.0/ .0	.0/ .1
	H%	100.0/100.0	27.8/ 20.8	16.7/ .0	35.6/ 35.4	18.9/ 33.3	.0/ 4.2	.0/ .0	1.1/ 6.3
NIH Fellowship	N	246/ 196	29/ 7	4/ 0	129/ 83	77/ 86	1/ 1	3/ 10	3/ .9
	V%	1.3/ 2.0	.8/ 1.2	.2/ .0	3.5/ 5.0	2.3/ 3.9	.1/ .1	.3/ 2.1	.1/ .3
	H%	100.0/100.0	11.8/ 3.6	1.6/ .0	52.4/ 42.3	31.3/ 43.9	.4/ .5	1.2/ 5.1	1.2/ 4.6
NIH Traineeship	N	854/ 535	43/ 12	26/ 2	597/ 347	170/ 157	2/ 1	8/ 6	8/ 10
	V%	4.4/ 5.4	1.2/ 2.0	1.0/ 1.7	16.4/ 21.1	5.0/ 7.0	.1/ .1	.7/ 1.3	.2/ .3
	H%	100.0/100.0	5.0/ 2.2	3.0/ .4	69.9/ 64.9	15.9/ 29.3	.2/ .2	.9/ 1.1	.9/ 1.9
NDEA Fellowship	N	152/ 110	9/ 2	0/ 0	4/ 1	42/ 22	77/ 68	1/ 0	19/ 17
	V%	.8/ 1.1	.2/ .3	.0/ .0	.1/ .1	1.2/ 1.0	4.2/ 4.7	.1/ .0	.6/ .5
	H%	100.0/100.0	5.9/ 1.8	.0/ .0	2.6/ .9	27.6/ 20.0	50.7/ 61.8	.7/ .0	12.5/ 15.5
Graduate & Prof. Opportunities Program	N	48/ 58	6/ 9	3/ 3	12/ 14	11/ 15	2/ 3	3/ 1	11/ 13
	V%	.2/ .6	.2/ 1.5	.1/ 2.6	.3/ .9	.3/ .7	.1/ .2	.3/ .2	.3/ .4
	H%	100.0/100.0	12.5/ 15.5	6.3/ 5.2	25.0/ 24.1	22.9/ 25.9	4.2/ 5.2	6.3/ 1.7	22.9/ 22.4
National Direct Student Loans	N	2524/ 1700	253/ 39	124/ 3	394/ 200	761/ 574	367/ 287	150/ 90	474/ 506
	V%	13.0/ 17.1	7.0/ 6.6	5.0/ 2.6	10.8/ 12.2	22.3/ 25.8	20.1/ 20.0	13.2/ 19.1	14.2/ 14.8
	H%	100.0/100.0	10.0/ 2.3	4.9/ .2	15.6/ 11.8	30.2/ 33.8	14.5/ 16.9	5.9/ 5.3	18.8/ 29.8
Other HEW	N	380/ 345	27/ 2	18/ 1	80/ 81	174/ 145	10/ 14	31/ 19	39/ 83
	V%	2.0/ 3.5	.7/ .3	.7/ .9	2.2/ 4.9	5.1/ 6.5	.5/ 1.0	2.7/ 4.0	1.2/ 2.4
	H%	100.0/100.0	7.1/ .6	4.7/ .3	21.1/ 23.5	45.8/ 42.0	2.6/ 4.1	8.2/ 5.5	10.3/ 24.1
GI Bill	N	1222/ 55	101/ 2	81/ 1	140/ 8	271/ 17	138/ 3	130/ 2	359/ 22
	V%	6.3/ .6	2.8/ .3	3.3/ .9	3.8/ .5	8.0/ .8	7.5/ .2	11.5/ .4	10.7/ .6
	H%	100.0/100.0	8.3/ 3.6	6.6/ 1.8	11.5/ 14.5	22.2/ 30.9	11.3/ 5.5	10.6/ 3.6	29.4/ 40.0
Other Federal[3] Support	N	1159/ 445	225/ 31	192/ 12	260/ 85	250/ 136	89/ 61	45/ 13	98/ 107
	V%	6.0/ 4.5	6.2/ 5.2	7.7/ 10.3	7.1/ 5.2	7.3/ 6.1	4.9/ 4.2	4.0/ 2.8	2.9/ 3.1
	H%	100.0/100.0	19.4/ 7.0	16.6/ 2.7	22.4/ 19.1	21.6/ 30.6	7.7/ 13.7	3.9/ 2.9	8.5/ 24.0
Other National[4] Fellowship	N	540/ 418	87/ 19	55/ 7	104/ 55	125/ 119	101/ 140	25/ 20	42/ 58
	V%	2.8/ 4.2	2.4/ 3.2	2.2/ 6.0	2.9/ [illegible]3	3.7/ 5.3	5.5/ 9.7	2.2/ 4.3	1.3/ 1.7
	H%	100.0/100.0	16.1/ 4.5	10.2/ 1.7	19.3/ [illegible].2	23.1/ 28.5	18.7/ 33.5	4.6/ 4.8	7.8/ 13.9
University Fellowship	N	3791/ 2030	748/ 148	379/ 23	64[illegible]/ [illegible]55	810/ 535	715/ 531	212/ 99	279/ 336
	V%	19.5/ 20.5	20.7/ 24.9	15.2/ 19.7	17[illegible]/ 21.6	23.8/ 24.0	39.1/ 37.0	18.7/ 21.1	8.3/ 9.8
	H%	100.0/100.0	19.7/ 7.3	10.0/ 1.1	17.0/ 17.5	21.4/ 26.4	18.9/ 26.2	5.6/ 4.9	7.4/ 16.6
Teaching Assistantship	N	9453/ 4274	2546/ 451	1050/ 46	1504/ 664	1843/ 1103	1229/ 986	536/ 217	744/ 804
	V%	48.5/ 43.1	70.4/ 75.9	42.2/ 39.3	41.3/ 40.4	54.1/ 49.5	67.2/ 68.6	47.3/ 46.2	22.2/ 23.5
	H%	100.0/100.0	26.9/ 10.6	11.1/ 1.1	15.9/ 15.5	19.5/ 25.8	13.0/ 23.1	5.7/ 5.1	7.9/ 18.8
Research Assistantship	N	8524/ 2968	2543/ 395	1732/ 71	1974/ 783	1294/ 825	226/ 218	269/ 134	483/ 540
	V%	43.8/ 29.9	70.3/ 66.5	69.6/ 60.7	54.2/ 47.6	38.0/ 37.0	12.3/ 15.2	23.7/ 28.5	14.4/ 15.8
	H%	100.0/100.0	29.8/ 13.3	20.3/ 2.4	23.2/ 26.4	15.2/ 27.8	2.7/ 7.3	3.2/ 4.5	5.7/ 18.2
Educ. Funds of Industry	N	735/ 245	207/ 46	201/ 19	92/ 52	59/ 33	18/ 17	71/ 18	87/ 60
	V%	3.8/ 2.5	5.7/ 7.7	8.1/ 16.2	2.5/ 3.2	1.7/ 1.5	1.0/ 1.2	6.3/ 3.8	2.6/ 1.8
	H%	100.0/100.0	28.2/ 18.8	27.3/ 7.8	12.5/ 21.2	8.0/ 13.5	2.4/ 6.9	9.7/ 7.3	11.8/ 24.5
Other Institutional Funds	N	1511/ 1018	207/ 34	111/ 8	303/ 168	300/ 233	218/ 187	90/ 63	280/ 324
	V%	7.8/ 10.3	5.7/ 5.7	4.5/ 6.8	8.3/ 10.2	8.8/ 10.5	11.9/ 13.0	7.9/ 13.4	8.4/ 9.5
	H%	100.0/100.0	13.7/ 3.3	7.3/ .8	20.1/ 16.5	19.9/ 22.9	14.4/ 18.4	6.0/ 6.2	18.5/ 31.8
Own Earnings	N	9586/ 6056	979/ 161	772/ 37	1229/ 616	2055/ 1376	1180/ 866	724/ 313	2642/ 2680
	V%	49.2/ 61.1	27.1/ 27.1	31.0/ 31.6	33.7/ 37.6	60.3/ 61.7	64.5/ 60.3	63.9/ 66.6	79.0/ 78.5
	H%	100.0/100.0	10.2/ 2.7	8.1/ .6	12.8/ 10.2	21.4/ 22.7	12.3/ 14.3	7.6/ 5.2	27.6/ 44.3
Spouse's Earnings	N	5135/ 3382	714/ 127	386/ 31	954/ 426	1028/ 732	591/ 502	371/ 178	1089/ 1384
	V%	26.4/ 34.1	19.7/ 21.4	15.5/ 26.5	26.2/ 25.9	30.2/ 32.8	32.3/ 34.9	32.7/ 37.9	32.6/ 40.5
	H%	100.0/100.0	13.9/ 3.8	7.5/ .9	18.6/ 12.6	20.0/ 21.6	11.5/ 14.8	7.2/ 5.3	21.2/ 40.9
Family Contributions	N	3589/ 1920	532/ 78	494/ 8	667/ 280	784/ 570	483/ 391	203/ 87	425/ 506
	V%	18.4/ 19.4	14.7/ 13.1	19.9/ 6.8	18.3/ 17.0	23.0/ 25.6	26.4/ 27.2	17.9/ 18.5	12.7/ 14.8
	H%	100.0/100.0	14.8/ 4.1	13.8/ .4	18.6/ 14.6	21.8/ 29.7	13.5/ 20.4	5.7/ 4.5	11.8/ 26.4
Other Loans	N	2286/ 1434	273/ 36	159/ 11	376/ 168	609/ 447	271/ 199	142/ 76	456/ 495
	V%	11.7/ 14.5	7.5/ 6.1	6.4/ 9.4	10.3/ 10.2	17.9/ 20.1	14.8/ 13.8	12.5/ 16.2	13.6/ 14.5
	H%	100.0/100.0	11.9/ 2.5	7.0/ .8	16.4/ 11.7	26.6/ 31.2	11.9/ 13.9	6.2/ 5.3	19.9/ 34.5
Other	N	1535/ 618	218/ 28	242/ 10	332/ 114	223/ 130	151/ 100	125/ 40	244/ 196
	V%	7.9/ 6.2	6.0/ 4.7	9.7/ 8.5	9.1/ 6.9	6.5/ 5.8	8.3/ 7.0	11.0/ 8.5	7.3/ 5.7
	H%	100.0/100.0	14.2/ 4.5	15.8/ 1.6	21.6/ 15.4	14.5/ 21.0	9.8/ 16.2	8.1/ 6.5	15.9/ 31.7
Unduplicated Total	N	19472/ 9915[5]	3619/ 594	2487/ 117	3642/ 1645	3406/ 2229	1830/ 1437	1133/ 470	3345/ 3415

[1] Includes mathematics and computer sciences.

[2] V denotes vertical percentage; H denotes horizontal percentage.

[3] Includes AEC/ERDA Fellowship and NASA Traineeship which were formerly shown separately.

[4] Includes Woodrow Wilson Fellowship which was formerly shown separately.

[5] The 1,823 Ph.D.s who did not report source of support are omitted from this table.

Source: Summary Report 1983: Doctorate Recipients, National Research Council

Table 1.4.3

Postgraduation Plans of Doctorate Recipients Entering the U.S. Labor Force by Field of Doctorate, 1969-1983

Postgraduation Plans	Year of Doctorate														
	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
Total Doctorates	23833	27261	29254	30295	31189	30614	30508	30516	29440	28719	28946	28770	28925	28685	28716
Seeking Appointment	18.5	19.6	20.4	22.1	23.8	24.8	25.6	26.6	27.0	26.4	26.1	24.4	25.0	25.7	27.1
Postdoctoral Study	3.1	2.9	3.3	3.8	4.2	4.4	4.3	4.5	4.9	4.9	4.4	4.7	5.0	5.1	5.4
Employment	15.4	16.7	17.1	18.4	19.6	20.4	21.3	22.1	22.1	21.6	21.7	19.7	20.1	20.6	21.6
Definite Plans	76.1	75.5	73.5	70.6	69.8	65.5	67.6	66.3	65.3	65.8	66.7	69.4	68.6	67.3	66.2
Postdoctoral Study	10.2	11.0	10.8	11.0	11.0	9.9	11.2	11.8	12.0	13.1	13.3	13.7	13.3	13.4	13.8
Employment	66.0	64.5	62.7	59.6	58.7	55.7	56.4	54.5	53.3	52.7	53.4	55.7	55.3	53.8	52.4
Academe	46.7	45.8	45.9	43.9	42.0	38.5	38.3	37.5	35.6	34.1	33.3	34.3	33.5	31.8	31.9
Business/Industry	10.3	9.7	7.4	6.0	6.8	7.4	7.6	6.7	7.3	8.3	9.3	10.2	10.8	11.8	10.5
Government	5.7	5.7	6.5	6.9	6.7	6.6	7.1	6.8	6.9	6.4	6.8	6.8	6.9	5.9	5.5
Nonprofit	2.1	2.2	2.1	2.2	2.6	2.7	3.0	3.0	3.2	3.5	3.5	3.9	3.6	3.9	3.6
No Report	1.1	1.1	.8	.5	.5	.4	.5	.4	.4	.4	.5	.5	.6	.5	.7
Plans Not Reported	5.3	4.8	6.1	7.3	6.4	9.7	6.7	7.1	7.6	7.7	7.2	6.2	6.4	7.0	6.7
Physics & Astronomy	1325	1512	1524	1439	1436	1197	1176	1119	1044	995	1010	999	925	933	922
Seeking Appointment	22.5	23.8	25.8	24.0	26.7	29.3	29.3	29.9	27.2	23.7	21.7	20.7	22.6	25.4	29.0
Postdoctoral Study	8.5	8.3	9.1	9.2	11.8	13.0	13.7	13.9	13.3	11.4	9.4	10.0	10.2	13.3	12.7
Employment	14.0	15.5	16.7	14.8	15.0	16.3	15.6	16.0	13.9	12.4	12.3	10.7	12.4	12.1	16.3
Definite Plans	70.7	69.8	64.0	65.7	64.3	60.2	62.2	59.4	61.8	68.8	70.4	71.7	70.2	66.9	65.6
Postdoctoral Study	24.8	26.5	26.4	30.2	30.8	30.8	33.3	33.0	32.8	37.1	37.0	37.4	34.2	32.3	34.3
Employment	46.0	43.3	37.6	35.5	33.4	29.4	28.9	26.5	29.0	31.8	33.4	34.4	36.0	34.6	31.3
Academe	19.3	19.2	18.0	16.5	11.8	9.8	8.8	10.0	10.5	8.0	8.2	8.0	7.1	7.9	9.2
Business/Industry	15.5	13.0	10.7	6.7	9.5	8.6	10.3	8.9	9.5	15.3	16.6	18.1	21.3	19.6	15.7
Government	7.8	8.1	7.2	11.1	10.8	9.8	8.6	6.8	8.3	7.4	7.1	7.6	6.9	6.6	6.1
Nonprofit	2.4	2.6	1.4	1.1	1.0	1.1	.9	.5	.6	.8	.8	.6	.4	.4	.3
No Report	.8	.3	.2	.1	.2	.2	.3	.2	.1	.2	.6	.1	.2	.0	.0
Plans Not Reported	6.8	6.4	10.2	10.3	9.0	10.4	8.4	10.6	11.0	7.4	7.9	7.6	7.2	7.7	5.4
Chemistry	1841	2085	2000	1817	1728	1670	1652	1505	1481	1452	1481	1444	1517	1576	1648
Seeking Appointment	15.8	17.9	19.4	23.4	24.0	22.8	20.8	22.1	22.6	21.2	17.7	19.1	17.3	16.4	22.5
Postdoctoral Study	6.1	5.9	6.9	10.7	11.6	12.0	9.7	11.6	11.3	10.8	8.1	9.9	8.4	7.7	10.6
Employment	9.6	12.1	12.5	12.7	12.4	10.8	11.1	10.5	11.3	10.4	9.6	9.2	8.9	8.7	12.0
Definite Plans	80.4	78.7	74.3	69.7	69.3	69.6	72.0	73.0	71.6	72.6	78.2	76.6	76.7	77.7	71.8
Postdoctoral Study	26.7	29.2	33.7	38.7	37.3	32.5	36.2	39.5	35.7	35.3	35.4	31.7	28.9	30.3	31.1
Employment	53.7	49.5	40.6	30.9	32.1	37.1	35.8	33.5	36.0	37.3	42.8	44.9	47.8	47.5	40.7
Academe	14.9	14.2	13.3	13.0	10.9	9.9	7.3	8.4	8.3	7.4	6.3	5.6	4.9	5.5	5.8
Business/Industry	32.8	29.3	21.9	11.3	16.6	22.1	24.7	20.6	23.4	26.6	31.3	35.4	38.4	39.5	31.4
Government	4.6	4.1	4.2	5.7	4.1	4.3	3.3	3.5	3.6	2.8	4.3	3.1	3.4	2.0	2.5
Nonprofit	.8	1.1	1.1	.7	.5	.6	.6	.9	.7	.6	.6	.6	.9	.3	.7
No Report	.6	.7	.3	.2	.1	.2	.0	.1	.0	.0	.3	.2	.2	.1	.2
Plans Not Reported	3.8	3.4	6.4	6.9	6.7	7.6	7.2	5.0	5.7	6.2	4.1	4.3	5.9	5.8	5.7
Mathematics	999	1133	1150	1155	1100	1099	1033	901	852	776	708	681	650	649	619
Seeking Appointment	19.6	20.5	22.9	25.6	28.8	33.4	28.6	29.4	30.3	26.5	26.0	20.6	22.2	24.7	22.3
Postdoctoral Study	2.1	1.6	2.3	3.5	2.7	4.4	3.2	4.2	4.3	3.4	4.5	4.0	5.2	4.6	5.0
Employment	17.5	18.9	20.6	22.2	26.1	29.0	25.4	25.2	25.9	23.2	21.5	16.6	16.9	20.0	17.3
Definite Plans	76.6	74.3	71.3	68.6	64.1	57.8	63.4	64.4	61.7	67.0	66.4	72.4	71.8	68.6	68.8
Postdoctoral Study	6.2	4.6	4.2	5.0	5.0	4.3	5.4	4.9	5.8	8.0	6.1	8.4	9.4	11.6	13.2
Employment	70.4	69.7	67.1	63.5	59.1	53.5	58.0	59.5	56.0	59.0	60.3	64.0	62.5	57.0	55.6
Academe	58.6	55.1	56.8	49.9	45.1	41.2	43.3	46.2	40.6	42.7	42.7	46.3	43.8	41.9	43.3
Business/Industry	6.6	8.9	6.1	7.3	8.0	7.9	8.5	7.4	10.1	11.1	10.7	13.2	13.5	9.4	7.6
Government	3.7	3.4	3.0	5.3	5.2	3.6	5.4	5.2	4.8	4.5	5.8	3.5	4.3	4.9	3.2
Nonprofit	1.1	1.9	.7	.9	.8	.6	.8	.2	.5	.8	.8	.6	.5	.5	.8
No Report	.4	.4	.5	.3	.0	.1	.0	.4	.0	.0	.3	.4	.3	.3	.6
Plans Not Reported	3.8	5.2	5.8	5.8	7.1	8.8	8.0	6.2	8.0	6.4	7.6	7.0	6.0	6.8	8.9

NOTE: Details may not add to totals because of rounding.

Source: Summary Report 1983: Doctorate Recipients, National Research Council

CHAPTER II

EARNINGS

Starting Salaries*

After poor performances in 1982 and 1983, reported salaries for inexperienced BS chemists showed the largest increases since 1981 in both current and constant dollars. When compared against 1981 starting salaries, the change over the past three years is an increase of 7.6% in current dollars and a decrease of 5.9% adjusting for inflation.

Smaller percentage increases in the starting salaries of new chemists with advanced degrees placed those 1984 graduates at a disadvantage compared to the 1981 cohort. The small one year decline in starting salaries for MS holders is the most recent decrement in a total drop of 9.1% in current dollars for the three year period; a 22.6% decrease when adjusted for inflation. PhD starting salaries have performed much the same as those of BS graduates over the last three years: a small increase in current dollars (3.3%) and a decline in constant dollars (down 10.2%).

Table 2.1.1 shows average starting salaries paid to inexperienced chemistry graduates for 1983 and 1984, and gives additional information concerning the variation among individual salaries within each group. Table 2.1.3 presents corresponding information for chemical engineering graduates.

For inexperienced chemists, 1984 mean starting salaries were:

$18,681 for the BS, up 9.6%, or in constant dollars up 5.5%.
$23,796 for the MS, down 0.9%, or in constant dollars down 5.0%.
$32,075 for the PhD, up 1.5%, or in constant dollars down 2.6%.

Chemical engineers continue to receive larger starting salaries than do chemists with similar degrees. Among chemical engineers the 1984 mean starting salaries were:

$26,259 for the BS, up 3.8%, or in constant dollars down 0.3%.
$30,619 for the MS, up 7.8%, or in constant dollars up 3.7%.
$38,947 for the PhD, up 6.8%, or in constant dollars up 2.7$.

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*Source: Starting Salaries 1984. American Chemical Society

Table 2.1.1

STARTING YEARLY SALARIES OF INEXPERIENCED FULL-TIME EMPLOYED CHEMISTRY GRADUATES

by Degree: Summer 1983 and Summer 1984

Salaries	Bachelor's 1983	Bachelor's 1984	Master's 1983	Master's 1984	Ph.D. 1983	Ph.D. 1984
90th Percentile	$22,500	$24,000	$32,800	$30,760	$36,882	$36,504
75th Percentile	20,000	21,600	28,625	28,550	35,000	35,500
50th Percentile	16,530	18,800	24,920	26,000	33,550	34,200
25th Percentile	14,000	16,000	17,000	18,300	29,281	31,000
10th Percentile	12,000	13,000	15,140	15,600	21,550	20,800
Mean	17,044	18,681	24,009	23,796	31,613	32,075
Count	174	274	26	25	70	107
Standard Deviation	4,325	4,435	6,787	5,906	5,644	5,824

Source: Starting Salaries 1984. American Chemical Society

Table 2.1.2

MEDIAN STARTING SALARIES OF B.S. INEXPERIENCED CHEMISTS IN PRIVATE INDUSTRY
by Sex: 1971 through 1984

Year	Men	Women	Women's Salaries As % of Men's
1971	8,300	7,800	94.0
1972	8,400	7,800	93.0
1973	9,000	8,500	94.0
1974	9,800	10,000	102.0
1975	10,000	9,600	96.0
1976	10,800	10,900	101.0
1977	12,000	12,000	100.0
1978	12,500	13,000	104.0
1979	15,000	15,600	104.0
1980	16,800	16,750	99.7
1981	17,000	18,500	108.8
1982	17,000	17,000	100.0
1983	17,000	16,000	94.1
1984	19,000	18,500	97.4

SOURCE: ACS Starting Salary Survey series.

Table 2.1.3

STARTING YEARLY SALARIES OF INEXPERIENCED FULL-TIME EMPLOYED CHEMICAL ENGINEERING GRADUATES

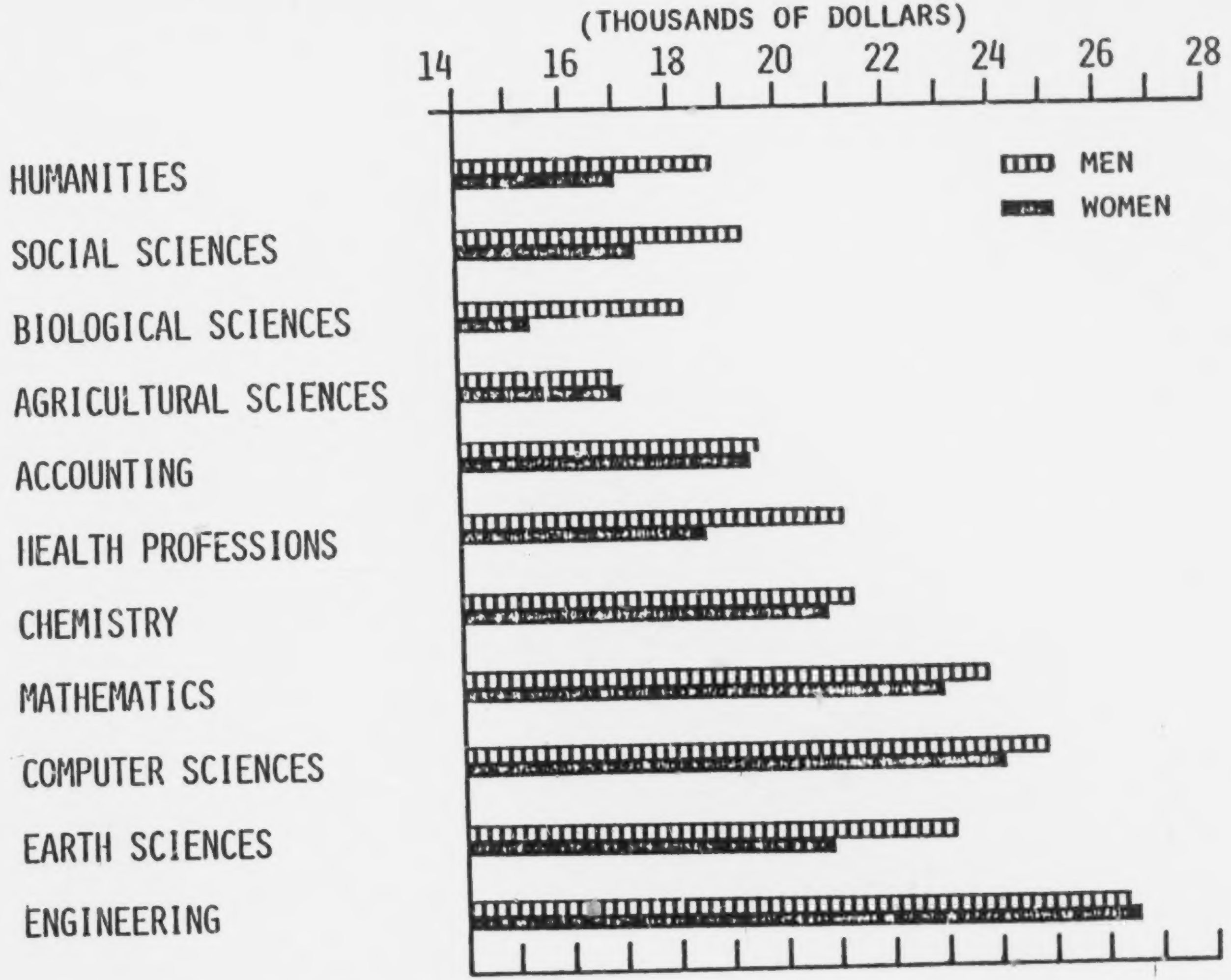
by Degree: Summer 1983 and Summer 1984

	DEGREE LEVEL					
Salaries	Bachelor's		Master's		Ph.D.	
	1983	1984	1983	1984	1983	1984
90th Percentile	$28,200	$29,100	$32,010	$32,420	$40,400	$40,400
75th Percentile	27,500	28,200	30,000	31,400	39,500	41,875
50th Percentile	26,100	27,000	29,250	30,300	38,000	39,950
25th Percentile	24,000	25,500	26,880	30,000	35,650	38,000
10th Percentile	20,000	21,488	24,994	28,900	26,000	30,300
Mean	25,281	26,259	28,392	30,619	36,476	38,947
Count	335	473	46	47	17	20
Standard Deviation	3,809	3,417	3,821	3,002	4,993	3,926

Source: Starting Salaries 1984. American Chemical Society

Figure 2.1.4

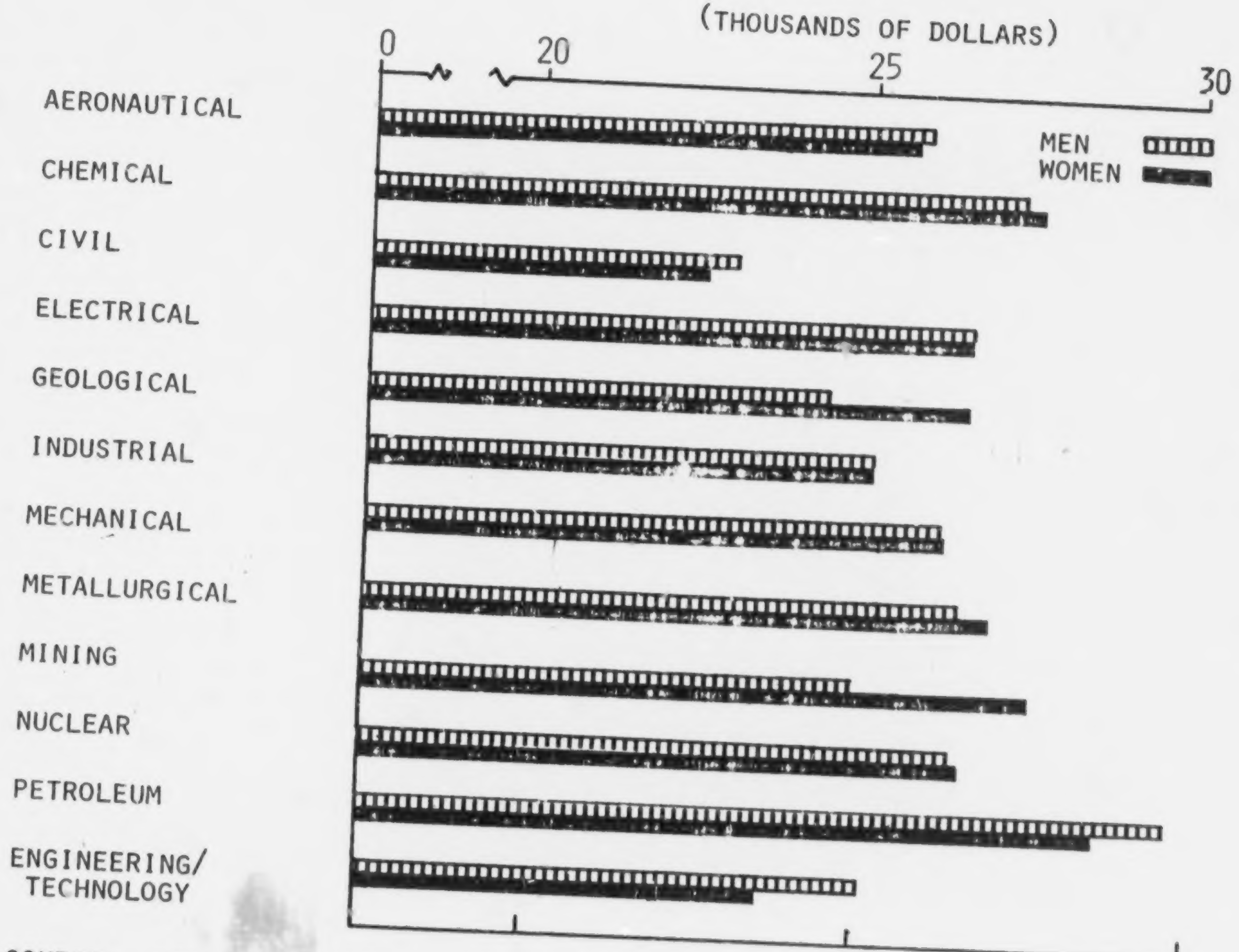
BEGINNING OFFERS TO BACHELOR'S GRADUATES, 1984



SOURCE: COLLEGE PLACEMENT COUNCIL

Figure 2.1.5

AVERAGE ANNUAL SALARY OFFERS TO BACHELOR'S GRADUATES IN ENGINEERING, 1984



SOURCE: COLLEGE PLACEMENT COUNCIL

Table 2.1.6

SOURCE: The College Placement Council, CPC Salary Survey - A Study of 1982-83 Beginning Offers Formal Report, No. 3, July 1983.

NUMBER AND AVERAGE STARTING MONTHLY SALARY OFFERS TO INEXPERIENCED BACHELOR'S DEGREE CANDIDATES BY CURRICULUM, JULY 1982 AND JULY 1983

CURRICULUM	No. Offers	Average $ Offers		Percent Change in $ Offers July 1982
		July 1983	July 1982	
BUSINESS				
Accounting	5,618	$1,565	$1,545	1.3%
Business - General (includes Management)	3,272	1,486	1,477	0.6
Marketing & Distribution	1,457	1,411	1,370	3.0
ENGINEERING				
Aeronautical	439	2,004	1,973	1.6
Chemical	1,156	2,228	2,256	-1.2
Civil	892	1,869	1,925	-2.9
Electrical (including Computer Engineering)	8,285	2,128	2,064	3.1
Geological	35	2,089	2,253	-7.3
Industrial	841	2,048	2,023	1.2
Mechanical	3,883	2,096	2,098	-0.1
Metallurgical (includes Metallurgy & Engineering Ceramics)	277	2,146	2,106	1.9
Mining	30	2,041	2,114	-3.5
Nuclear (includes Engineering Physics)	114	2,078	2,039	1.9
Petroleum	307	2,568	2,539	1.1
Technology	624	2,006	1,958	2.5
HUMANITIES & SOCIAL SCIENCES				
Humanities	715	1,380	1,283	7.6
Economics*	577	1,590	1,543	3.1
Other Social Sciences	810	1,320	1,286	2.6
SCIENCES				
Agricultural	297	1,375	1,391	-1.2
Biological	149	1,419	1,375	3.2
Chemistry	147	1,712	1,751	-2.2
Computer Science	2,572	1,941	1,908	1.7
Health (Medical) Professions	423	1,584	1,492	6.2
Mathematics	517	1,799	1,777	1.2
Other Physical & Earth Sciences	167	1,746	1,980	-11.8

* Includes economics programs with both business and social science orientation.

Reprinted from Salaries of Scientists, Engineers and Technicians, Scientific Manpower Commission, November 1983.

SOURCE: A Midyear Review of the Northwestern Endicott Report - 1983, by Victor R. Lindquist.

AVERAGE STARTING SALARIES OF DOCTORAL RECIPIENTS IN BUSINESS AND INDUSTRY, 1983

DISCIPLINE-FIELD	AVERAGE STARTING SALARY
Aeronautical Engineering	$39,000
Biology	33,700
Chemistry	34,700
Chemical Engineering	38,500
Civil Engineering	32,204
Computer Science	38,255
Electrical Engineering	39,036
Engineering Science	31,000
Geology	35,900
Geophysics	37,352
Law	30,200
Materials/Metallurgy	36,490
Mathematics	33,150
Mechanical Engineering	38,200
Medical	70,000
Nuclear Engineering	37,860
Oceanography	29,000
Ocean Engineering	38,500
Operations/Systems	36,320
Pharmacology	35,000
Psychology	31,000
Physics	34,900
Statistics	30,000

NOTE: Salaries listed are averages of data compiled from offers extended and accepted and offers of employment extended but not yet accepted.

Reprinted from Salaries of Scientists, Engineers and Technicians, Scientific Manpower Commission, November 1983.

Salaries of Experienced Chemists

Salaries tend to reflect the marketplace. For chemical engineers in 1983, only PhDs earned median annual salaries higher than 1982 (up 8% from $45,000 to $48,500). Increases in median annual salaries occurred at all degree levels for chemists, but the largest increase was only 7% (from $37,500 to $40,000 for PhDs).

EMPLOYER

Industrial Chemists. Median salaries for MS chemists in private industry rose faster than did those for other degree levels and increased 7.6% from $33,000 in 1982 to $35,500 in 1983. Industrial BS chemists' salaries grew by 6.6% from $29,000 to $30,000 and PhD chemists' salaries rose by 6.4% from $42,000 to $44,700. After allowance for inflation, median salaries for chemists showed only modest gains of 2.9%, 3.8% and 2.7% for BS, MS and PhD chemists, respectively.

For chemists working in private industry 1983 salaries were

$30,900 for the BS, up 6.6% from 1982, up 2.9% in constant dollars.
$35,500 for the MS, up 7.6% from 1982, up 3.8% in constant dollars.
$44,700 for the PhD, up 6.4% from 1982, up 2.7% in constant dollars.

(Prices as measured by the official Consumer Price Index for Urban Workers increased 3.6% between March 1982 and March 1983.)

At each degree level, industrial chemists working as R&D and general managers earned more than chemists working as researchers. With the exception of the MS chemists, general managers had higher salaries than R&D managers.

In 1982, at all these degree levels, chemists working with polymers generally earned more than chemists in other specialties but in 1983, salaries vary by degree and specialty. At the BS level, physical chemists had the highest median salaries: $38,000. Inorganic chemists earned the highest salaries at the MS level: $40,400. For both the BS and MS chemists, biochemists were paid the lowest salaries ($24,000 and $30,000 respectively). At the doctorate level, environmental chemists earned the most ($47,000) and analytical chemists the least ($40,690).

Chemist working in the petroleum industry, which employed almost 7% of all industrial chemists, were paid the highest salaries. In general, the chemical industry ranked second in salaries and employed about one-third of all responding industrial chemists.

Academic Chemists. Median salaries for academics vary by rank and school type. Chemists teaching in non-doctorate granting chemistry departments earn less than those teaching in doctorate granting departments. Professors in PhD granting schools earned, on average, $44,000 whereas those of the same rank in non-PhD granting schools earned only $31,275. The differences in salaries between school types decreases with rank: associate professors at PhD granting schools earned approximately $32,000 while those in non-PhD granting schools earned $25,000.

Variations in the salaries between academic ranks and school type were small in comparison to the difference between academic chemists and industrial chemists. The typical PhD industrial chemist who received the BS 20-24 years ago earned $49,800 while a professor with the same background earned $35,000 and an associate professor received only $28,975.

Government Chemists. Chemists employed by a federal, state or local government represent 9% of all chemistry respondents. As of March 1, 1983 median salaries for member chemists in government were:

$29,000 for BS, up 10.2% from 1982, up 6.4% in constant dollars.
$31,700 for MS, up 2.2% from 1982, down 1.3% in constant dollars.
$43,000 for PhD, up 7.5% from 1982, up 3.8% in constant dollars.

Although government BS chemists made the largest gain, the median salaries for government chemists are still less than those working in industry. These salary differences, however, may be attributable to the variations in work experience among the respondents in these groups.

Sex. Salary differences between men and women shown in past editions of this survey report persist although the gap between salaries for men and women chemists is narrowing, especially for PhDs.

The difference between salaries paid to women and those paid to men of comparable experience is not so great as that between the overall averages. Part of the reason that women's overall average salary is less is that, as a group, the ACS women are younger than the men. This relative youth of the women in chemistry undoubtedly reflects changes in hiring practices that began decades ago, as well as the changes in the number of women chemists.

Age-adjusted average industrial and government salaries for women PhDs are now 92% of those of men, while academic womens' age-adjusted average salary is 82% of that of men. Most of the difference represents differentials between managerial and administrative salaries on the one hand and research and teaching salaries on the other. As in earlier years, few women PhDs report managerial or administrative positions.

Compared to 1983, median salaries reported in the survey reflect the modest gains of the 1983-1984 economic recovery. Although the March 1983-84 increase in the consumer price index was less than in recent years (somewhat under 5.0%) PhD chemists' overall median salaries increased approximately 5.5% (to $42,000) while master's and bachelor's degree chemists reported increases of 3% to $34,000 and $30,900 respectively. Overall, only PhD's increases represented an increase in constant dollars. Given these small increases, it is difficult to find dramatic difference in increase among geographic regions or employment sectors, although PhDs in industrial jobs fared slightly better than their academic colleagues with a 5.6% increase compared to 4.7% in academia. The median salary of all industrial PhDs was $47,200, that of all academic PhDs, $35,000, although large differences exist among chemists of varying seniority, academic rank and academic assignment (teaching, research or administration).

For the period 1970-1984, the relationship between starting salaries and salaries of experienced chemists is reported in Table 2.2.2. The ratio of these two median salary figures is a measure of "salary compression", providing information about the range of salaries across a chemist's career. This ratio is responsive to labor market demand for chemists, decreasing as demand rises, increasing as demand slackens. This occurs because salaries of mature chemists are not as market-dependent as beginning salaries.

Tables in Section 2.3 present comparisons that place chemists' salaries in the contexts of: an urban family budget for selected U.S. metropolitan areas, the income of other workers and the salaries of other scientists and engineers.

Source: Salary Survey 1983. American Chemical Society

Table 2.2.1

MEDIAN YEARLY SALARIES OF ACS MEMBER CHEMISTS
By Degree: 1960 through 1984
(in Current and 1967 Constant $1,000)

Year	Current Dollars			Consumer Price Index for March	1967 Dollars		
	Degree Level				Degree Level		
	B.S.	M.S.	Ph.D.		B.S.	M.S.	Ph.D.
1960	$ 9.0	$ 9.0	$11.0	88.1	$10.2	$10.2	$12.5
1962	9.0	10.0	12.0	90.3	10.0	11.1	13.3
1964	9.9	10.6	13.0	92.6	10.7	11.4	14.0
1966	10.5	11.6	14.0	96.3	10.9	12.0	14.5
1967	12.0	12.8	15.3	102.8	11.7	12.5	14.9
1968	No salary survey conducted						
1969	12.9	13.6	16.6	108.0	11.9	12.6	15.4
1970	14.0	14.9	17.5	114.5	12.2	13.0	15.3
1971	15.0	15.6	18.3	119.8	12.5	13.0	15.3
1972	15.6	16.3	19.2	124.0	12.6	13.1	15.5
1973	16.8	17.5	20.5	129.8	12.9	13.5	15.8
1974	17.5	18.4	21.7	143.1	12.2	12.9	15.2
1975	19.0	19.8	23.0	157.8	12.0	12.5	14.6
1976	19.8	20.5	24.7	167.5	11.8	12.2	14.7
1977	21.0	22.0	26.0	178.2	11.8	12.3	14.6
1978	22.0	24.0	27.4	189.7	11.6	12.7	14.4
1979	23.5	25.0	29.0	209.3	11.2	11.9	13.9
1980	25.0	26.0	31.2	239.8	10.4	10.8	13.0
1981	27.5	30.0	35.0	265.2	10.4	11.3	13.2
1982	28.5	31.6	37.5	282.5	10.1	11.2	13.3
1983	30.0	33.0	40.0	293.0	10.2	11.3	13.7
1984	30.9	34.0	42.0	303.3	10.2	11.2	13.8

SOURCES: ACS Salary Survey series.
U.S. Department of Labor, Bureau of Labor Statistics.

Table 2.2.2

MEDIAN YEARLY SALARIES OF NON-ACADEMIC B.S. CHEMISTS: 1970 - 1984

Year	ACS Member, 20-24 Years Since B.S. Degree	Starting Salary	Mature/ Beginning Salary Ratio
1970	16,500	8,880	1.86
1971	17,000	8,100	2.10
1972	17,500	8,300	2.11
1973	18,400	9,000	2.04
1974	19,800	9,900	2.00
1975	21,600	10,000	2.16
1976	22,500	10,800	2.08
1977	24,000	12,000	2.00
1978	26,100	12,700	2.06
1979	28,200	14,500	1.94
1980	30,000	15,000	2.00
1981	32,400	17,730	1.83
1982	35,000	17,000	2.06
1983	37,800	16,530	2.29
1984	38,640	19,500	1.98

MEDIAN YEARLY SALARIES OF NON-ACADEMIC PhD CHEMISTS: 1970 - 1984

Year	ACS Member, 20-24 Years Since B.S. Degree	Starting Salary	Mature/ Beginning Salary Ratio
1970	21,000	14,700	1.43
1971	22,100	14,400	1.53
1972	23,000	13,300	1,73
1973	24,300	14,900	1.63
1974	25,500	16,200	1.57
1975	27,700	17,000	1.63
1976	28,800	18,300	1.57
1977	30,000	19,500	1.54
1978	32,000	21,000	1.52
1979	33,000	23,000	1.43
1980	32,400	26,400	1.23
1981	36,000	29,500	1.22
1982	40,000	32,400	1.23
1983	41,000	33,550	1.22
1984	50,000	34,400	1.45

Source: ACS Starting Salary Survey series.
ACS Comprehensive Salary Survey series.

A REGRESSION MODEL FOR ESTIMATING CHEMIST'S AVERAGE SALARIES

A compact summary of the information in this report is possible through a statistical technique known as multiple linear regression. This technique identifies which characteristics have the greatest effect on salaries, and results in a formula for estimating the average salary of respondents with certain characteristics.

For industrial chemists responding to the 1984 survey, the three characteristics which account for most of the variation among salaries are highest degree, experience (years since B.S. is used to measure experience in ACS surveys), and work function. For academic chemists, the most important characteristics were rank, the highest degree offered by the respondent's department, and the control (public or private) of the respondent's institution.

Table I displays the factors needed to estimate the average salary for any group of respondents who are industrial chemists with any combination of the listed characteristics.

For example, to estimate the average salary in March 1984 for industrial chemists with the doctorate, 15 to 19 years of experience, and working in R&D management, find the corresponding factors in Table I and multiply them together with the base salary for all industrial chemists:

$$(\$20{,}563) \times (1.271) \times (1.666) \times (1.165) = \$50{,}726$$

Table II displays factors associated with salaries of academic chemists responding to the survey. To estimate the approximate average salary in March 1984 of associate professors at public colleges whose departments offer the doctorate, multiply the corresponding factors together with the base salary for all academic chemists:

$$(\$32{,}620) \times (.774) \times (1.000) \times (1.319) = \$33{,}302$$

Averages estimated using this method should be interpreted with caution, for two reasons. First, and more important, is that the relationship between salary and employment characteristics is not exact. Variations due to employer (such as size of company, and geographic location), or to individual differences (such as ability, and number of people supervised), and other characteristics prohibit perfect estimation of an individual's salary. Secondly, the factors shown in the tables are estimates derived from a sample of chemists rather than the entire population of chemists, and as such are subject to the imprecision associated with sampling procedures.

Table 2.2.3

TABLE I

1984 SALARY FACTORS FOR INDUSTRIAL CHEMISTS

BASE SALARY	$21,706
DEGREE:	
Bachelors's	1.010
Master's	1.060
Doctorate	1.281
MATURITY: (Years Since Receiving B.S.)	
0-1	1.000
2-4	1.092
5-9	1.282
10-14	1.483
15-19	1.636
20-24	1.819
25-29	1.914
30-34	1.955
35-39	1.956
40 or more	1.975
WORK FUNCTION:	
Basic Research	1.000
R&D Management	1.177
Applied Research	0.984
General Management	1.183
Marketing	1.108
Production	0.936
Forensic/Lab Analysis	0.887
Writing	0.903
Data Processing	0.901
Consulting	0.990
Other	1.023

TABLE II

1984 SALARY FACTORS FOR ACADEMIC CHEMISTS

BASE SALARY	$21,871
RANK:	
Instructor	1.213
Assistant Professor	1.000
Associate Professor	1.246
Professor	1.630
Research Associate	1.307
Unranked Faculty Member	1.216

HIGHEST DEGREE OFFERED IN DEPARTMENT:	
Bachelor's or Master's	1.000
Doctorate	1.230
INSTITUTIONAL CONTROL:	
Private	0.975
Public	1.000

Source: Salary Survey 1983. American Chemical Society

Table 2.3.1

SALARIES PAID NON-ACADEMIC PhD CHEMISTS COMPARED WITH A FAMILY BUDGET FOR SELECTED METROPOLITAN AREAS

Salaries of Full-time Non-academic ACS-member Doctoral Chemists, Selected ACS Local Sections		BLS Higher Budget (2) for a 4-person Family, Selected Metropolitan Areas		PhD Chemists Salary as Percent of Higher Budget	
Local Section	Median Salary, March 1984 (based on standard weights) (1)	Metropolitan Area	Higher Budget for 4-person family March 1984		% change Fall '81-Mar '84
Northeastern	$46,280	Boston	$50,155	92%	+ 1
New York	47,625	New York & Northeastern New Jersey	53,087	90%	+ 4
North Jersey	51,930			98%	+ 7
Philadelphia	47,695	Philadelphia	44,545	107%	+ 6
Delaware	51,405			115%	- 2
Pittsburgh	47,906	Pittsburgh	40,092	119%	- 1
Washington, D. C.	44,485	Washington, D. C.	47,554	94%	- 9
Chicago	47,041	Chicago	40,881	115%	+ 8
Southeastern Texas	51,476	Houston, TX	39,347	131%	+13
Southern California	47,436	Los Angeles & Long Beach	41,058	116%	+ 7
		San Diego	40,325	118%	+ 7
California	51,414	San Francisco	44,097	117%	+ 6

SOURCE: U. S. Department of Labor, Bureau of Labor Statistics, Autumn 1981 Urban Family Budgets and Comparative Indexes for Selected Urban Areas.
ACS, Salaries 1984.

Consumer Price Index series 1982-84

(1) Each hypothetical salary in this column is a weighted mean calculated by applying a standard weight to the mean salary within each experience level. The standard weights reflect the distribution of ACS member chemists in the U.S. In effect, the hypothetical mean for a local section is what the average salary would be if chemists in that geographic area had the same age distribution as does the country as a whole.

(2) The Bureau of Labor Statistics annually publishes several hypothetical budgets for families living in metropolitan areas. The family budgets considered here are for a precisely defined urban family of four: a 38 year-old husband employed full-time, his non-working wife, a boy of 13, and a girl of 8. After about 15 years of married life, the family is settled in the community and the husband is an experienced worker. The family has (for this budget level) average inventories of clothing, house furnishings, major durables (including an automobile), and other equipment. The budget pertains only to an urban family with the specified characteristics. These budgets are for a family whose income is somewhat more than average.

Table 2.3.2

MEDIAN INCOME OF YEAR ROUND FULL-TIME WORKERS 25 YEARS OR OLDER, BY YEARS OF EDUCATION, 1983

	YEARS OF EDUCATION						
	Elementary		High School		College		
	< 8	8	1-3	4	1-3	4	5 or more
Men	$14,093	$16,438	$17,685	$21,823	$24,613	$29,892	$34,643
Women	9,385	10,337	11,131	13,787	16,536	18,452	22,877

Source: U.S. Department of Commerce, Bureau of Census, Money Income and Poverty Status of Families and Persons in the U.S. 1983, (Advance data from Current Population Surveys, P-60, No. 145, August 19, 1984)

Table 2.3.3

SALARIES OF SCIENTISTS AND ENGINEERS EMPLOYED IN RESEARCH AND DEVELOPMENT BY PROFESSION, 1982 and 1983

PROFESSION	Median Salary		% Increase
	1982	1983	
Mathematician	$36,950	$38,450	4.1%
Aeronautical Engineer	38,240	41,150	7.6
Chemical Engineer	35,340	38,890	10.1
Physicist	37,070	38,500	3.8
Electrical Engineer	35,250	37,480	6.3
Metallurgist	37,670	38,333	1.8
Mechanical Engineer	34,990	38,100	8.9
Chemist	32,190	34,880	8.4
Biologist	30,950	34,380	11.1
Industrial Engineer	29,950	30,520	1.9
Ceramist	35,950	38,400	6.8
Geologist	33,950	36,950	8.9
Other Professionals	30,670	32,450	5.8

SALARIES OF SCIENTISTS AND ENGINEERS EMPLOYED IN RESEARCH AND DEVELOPMENT BY DEGREE LEVEL, 1982 and 1983

DEGREE	MEDIAN SALARY		% Increase	Annual Difference		Difference Increase %*
	1982	1983		1982	1983	
Doctorate	$38,520	$40,590	5.4	$4,510	$4,310	-4.4
Master's	34,010	36,280	6.7	2,750	3,100	12.7
Bachelor's	31,260	33,180	6.1	6,490	5,100	-21.4
Less than Bachelor's	24,770	27,670	11.7			

*Difference above next-lower degree.

SOURCE: Industrial Research & Development Magazine, March 1983.

Table 2.3.4

MEDIAN ANNUAL SALARIES* OF DOCTORAL SCIENTISTS AND ENGINEERS BY YEARS SINCE PH.D, FIELD AND SEX, 1983

Sex & Years Since Ph.D.	FIELD OF DOCTORATE											
	All Fields	Math	Comp. Sci.	Phys./ Astrn.	Chem.	Earth/ Envir.	Engr.	Agric.	Med.	Biol.	Psych.	Social Sci.
	(In Thousands of Dollars)											
TOTAL	$40.2	$37.8	$42.1	$43.9	$42.8	$40.6	$46.5	$37.4	$40.2	$36.7	$35.8	$36.0
5 or less	30.9	27.8	38.4	36.7	35.1	32.1	37.6	28.5	31.8	26.7	28.0	27.5
6-10	35.1	34.5	45.2	38.8	38.7	36.8	44.2	34.6	37.5	31.9	32.7	32.5
11-15	41.1	37.5	49.5	43.2	42.5	44.4	46.6	38.9	42.9	37.2	39.0	37.8
16-20	44.9	41.4		45.2	45.8	46.9	51.5	42.6	50.3	41.7	40.5	42.7
21-25	48.5	48.0		49.6	48.8	51.9	55.1	43.7	52.4	45.9	45.6	45.8
26-30	50.9	50.7		57.1	50.9	52.9	59.1	46.9	54.4	48.2	49.5	48.8
Over 30	53.4	56.2		55.1	52.9	54.5	58.2	50.5	55.7	52.6	51.5	50.6
MALE, TOTAL	40.9	38.4	42.3	44.1	43.7	40.8	46.7	38.0	42.5	38.1	37.3	36.7
5 or less	32.1	27.6	38.0	36.8	35.3	32.1	37.7	28.7	33.0	27.1	28.7	28.0
6-10	36.7	35.0	45.3	38.8	39.1	36.9	44.2	34.7	38.9	33.2	33.8	32.8
11-15	42.0	37.8	49.7	43.3	43.0	44.6	48.6	39.0	44.5	38.0	39.9	38.2
16-20	45.2	41.6		45.3	46.5	47.8	51.5	42.6	50.6	42.7	40.6	43.9
21-25	48.9	48.6		49.7	50.1	52.0	55.1	43.8	55.2	46.8	46.1	46.1
26-30	51.6	51.2		57.3	51.8	53.3	59.1	47.0	55.4	49.3	50.0	49.0
Over 30	54.2	56.6		55.2	53.8	55.5	58.2	50.5	55.9	53.8	52.1	51.3
FEMALE, TOTAL	31.8	33.5	41.1	38.1	35.0	35.6	39.7	29.2	33.0	30.7	30.8	31.0
5 or less	27.6	29.4	39.8	34.3	33.7	32.6	36.3	27.5	30.0	25.2	26.2	26.7
6-10	31.1	32.3	45.1	38.1	35.4	35.1	43.5	30.6	34.3	29.6	30.6	31.6
11-15	34.9	35.8		38.2	34.6	35.7	45.0	33.7	36.6	33.6	34.7	35.9
16-20	36.9	36.2		40.8	34.0	42.0			45.5	34.6	39.7	37.0
21-25	40.3	37.1		41.0	38.4				40.6	40.7	41.6	42.4
26-30	42.6				36.8					43.2	43.0	40.1
Over 30	44.0				42.3					42.4	45.5	46.1

*Median salaries were computed only for Ph.D.s employed full-time, excluding those in the U.S. military. Academic salaries were multiplied by 11/9 to adjust for a full-time scale. Medians were not calculated for cells with less than 20 cases reporting salary.

Source: Opportunities in Science and Engineering, Scientific Manpower Commission, 1984

CHAPTER III

EMPLOYMENT AND DEMOGRAPHIC CHARACTERISTICS

Employment 1983

Jack G. Kay* and John Robert Jones**

Unemployment of chemists is worse than at any time since the 1976 recession. After hovering around 1% between 1979 and 1981, this year the unemployment rate climbed to 2.2%, up from 1.5% in 1982.

RECRUITING

The decline in the help wanted and classified and display advertising in *Chemical and Engineering News* since the first quarter of 1982 corresponds with the decline in the employment of chemists. A recent canvass of the employment status of new PhD chemistry graduates, carried out at the request of the Joint Board-Council Committee on Economic Status, showed that among the 632 citizens and/or permanent residents reported, 46.7% have permanent employment, 39.2% have accepted postdoctoral fellowships or other temporary employment, and 13.3% were still seeking employment as of April 22, 1983. Since this was the first survey of its kind, it is not clear if this unemployment rate is uncharacteristically high for this time of year.

According to the *College Placement Council Salary Survey*, March 1983, the decrease in the number of job offers since last year had the greatest impact on BS chemical engineers. Job offers made to BS chemical engineers dropped from 2,025 offers in 1982 to 458 offers in 1983. The comparable figures for BS chemists were 48 offers this year in contrast with 85 last year. The number of job offers made to PhD chemical engineers feel slightly from 23 to 19. Offers made to PhD chemists numbered 41 this year compared with 78 last year.

UNEMPLOYMENT RATES FROM 1983 SURVEY

Sex. Slightly more than 3% of women ACS members were unemployed compared with 1.9% of the men. In 1982, 2.7% of women chemists were seeking full-time employment compared with 1.3% of the men.

Highest Degree. Joblessness is less pervasive as the degree level increases: 2.9% of BS, 2.0% of MS, and 1.8% of PhD chemists were seeking employment. The comparable unemployment figures in 1982 were: 2.2% of BS, 1.3% of MS and 1.2% of PhD chemists.

Race. In 1982, both minority and non-minority groups had an unemployment rate of roughly 1.5%. This year 3.3% of minority chemists are seeking employment as compared with 2.1% of non-minority chemists. The growth in unemployment had its strongest impact on minority women chemists. Five percent of minority women chemists and 3.1% of non-minority women chemists were unemployed compared with 2.9% of minority men chemists and 1.9% of non-minority men chemists. (See Table A at the end of this article.)

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*Dr. Kay is professor and Head of Chemistry at Drexel University and is a member of the ACS Committee on Economic Status.

**Mr. Jones is Manager of ACS Statistical Services.

Work Specialty. Environmental chemistry had the largest proportion of unemployed chemists while biochemistry and organic chemistry had the smallest percent unemployed. In comparison with last year, organic and polymer chemists experienced the greatest increase in unemployment rates. The percent of unemployed organic chemists doubled from 1.1% to 2.2%, and unemployed polymer chemists more than doubled from 1.3% to 2.8%.

Employer. Chemists whose most recent employer was a hospital, a non-profit research organization, or who were self-employed are more likely to be unemployed than those who worked for private industry, academia, or government. Almost 3.6% of chemists who worked for these "other" employers were unemployed, while 2.2% of industrial, 1.5% of academic, and 1.2% of government chemists were seeking employment.

Teaching represents the highest level of job security whereas marketing has the highest unemployment rate. (See Table B at the end of this article.) This finding deviates from the previous statement which indicated that government chemists were the least likely to be unemployed. However, since research and development, which has the second largest joblessness rate, is performed by all employers, teaching appears to be the most secure work function.

In view of the recent publicity given to the need for improving science education in high schools, it is interesting to note that 0.9% of the respondents are high school teachers and that 86.0% were employed full-time. In addition, 3.5% of these chemists were unemployed and 5.8% were employed part-time. Thus, high school teachers represent the largest fraction of members working part-time. One can speculate that the large percentage of part-time workers resulted from anticipated declining school enrollments making it undesirable to overstaff faculty positions.

Age. The unemployment rate for chemists who are 30 to 59 years old ranges from 1.6% to 2.3% - except for those 35-39, who have an unemployment rate of 2.6%. Unemployment is virtually non-existent for chemists 65 years old and over. However, joblessness is critical for chemists under the age of 30 (2.5% of those 20-24 and 2.7% of those 25-29 were unemployed). For the 25-29 age group, 9.6% have postdoctoral employment and for the 30-34 age group, 5.5% are employed in a postdoctoral capacity. Presumably, if it were not for the availability of postdoctoral positions, unemployment could be a much more severe problem at a critical time in the beginning of a young chemist's career.

Citizenship. Some U.S. chemists maintain that foreigners are competing significantly with citizens for chemistry positions. However, of those holding full-time employment, only 0.5% of those jobs are held by non-U.S. citizens. Among chemists holding postdoctoral positions, 74.5% are citizens, 8.9% are permanent residents and 16.2% are non-U.S. citizens. Slightly less than 90% of U.S. chemists, 87% of permanent resident chemists, and 46% of non-U.S. citizen chemists are employed full-time. Given these figures, it is difficult to support an argument that foreigners are competing significantly with U.S. citizens for jobs in chemistry.

TABLE A

Employment Status of Chemists According to Race

	Minority		Non-Minority	
	Men	Women	Men	Women
Postdoctoral	5.9	6.4	2.0	4.1
Full-time employed	89.6	84.4	93.9	85.2
Unemployed seeking	2.9	5.0	1.9	3.1
Unemployed not seeking	0.6	0.0	1.0	3.1
Part-time	1.0	4.3	1.2	4.5

TABLE B

Unemployment Rate of Chemists By Work Function

Most Recent Work Function	Percent Unemployed
R&D	1.9%
Teaching	1.6
Management	1.9
Marketing	2.6
Production & QC	3.3
Other	4.1

1. Includes Basic Research and Applied R&D
2. Does not include high school teachers
3. Includes R&D Management and General Management

Source: Salaries 1983. American Chemical Society.

Employment 1984

Jack G. Kay and Terrence Russell*

The overall unemployment rate among chemists has dropped from 2.2% in March, 1983 to 1.7% in 1984, still above the historic lows of 1979, 1980 and 1981 when the rate was around 1%. Each tenth of a percentage point represents approximately 90 ACS members in the U.S. work force.

Unemployment rates were not uniform for all chemists. Generally speaking, unemployment rates were higher for those who had the BS as the highest degree and were age 30 or younger (3.1% unemployed). Older chemists and those with the PhD were less likely to be unemployed.

While the level of unemployment fell, the percent of unemployed chemists experiencing long periods of unemployment increased. In 1983, 39.8% of those who were unemployed on March 1 were unemployed for 8 months or more. In 1984 44.1% had similar periods of unemployment. Differences in the duration of unemployment were most striking among geographic regions. In the east south-central states (Kentucky, Tennessee, Mississippi, and Alabama) 60% of those unemployed were out of work for eight months or more, while in New England and the Pacific coast states, the comparable figures were 14% and 23%.

Unemployment rates were higher for women chemists (2.6%) than for men (1.6%). Differences can be partially accounted for by the larger percentage of women in the sample who are under 35 (48.9% compared to 24.2% of the men) and hold the BS as the highest degree (37.2% compared to 23.9% of the men). Women chemists aged 35 and over had slightly lower unemployment rates than men in that age group (1.2% vs 1.4%), but much higher percentages of women in that group reported part-time employment (6.4% vs 1.6%).

Although a smaller percentage of both men and women held postdoctoral fellowships in 1984 than in 1983, a larger overall percentage of women held postdoctoral positions than did men (3.5% vs 2.8%). In the 25 to 30 age group the men's percentage was higher (10.4% vs 5.0%) but in the 30 to 35 age group, the women's percentage was higher (7.7% vs 4.7%), suggesting that these women PhDs are substituting longer postdoctoral fellowships for permanent employment.

Increased full time employment for women chemists may signal a partial victory for affirmative action, but such is not the case for minority chemists, whose unemployment rate in 1984 was 3.2%, only slightly changed from 3.3% in 1983. Full time employment for minority chemists actually was down from its 1983 level (87.7% vs 88.8%). For minority women, the rate of full time employment was 82.9%, a slightly lower figure than for 1983 (84.4%). For minority men, it was down from 89.6% last year to 88.9% this year. More minority chemists held postdoctoral positions (8.3% this year vs 6.0% last year) while part-time employment for minorities dropped from 1.5% to 0.8%.

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*Dr. Russell is an ACS Statistical Services staff member.

Source: Salaries 1984, Starting Salaries 1984. American Chemical Society.

Recruiting

Reflecting the modest improvement in the employment picture, the recruitment of recent graduates also increased during the past year.

ACS's second spring survey of PhD granting departments conducted in April, 1984 indicated that the recruitment of new PhDs into permanent positions was up slightly from April 1983 (48.6% vs 46.7%) with slight drops in the percentages of those who accepted postdoctoral or temporary positions (38.3% vs 39.2%) or who were still seeking employment (13.1% vs 13.3%).

The College Placement Council's CPC Salary Survey issued July, 1984 showed an increase in the number of offers made during the 1983-84 academic year as compared to 1982-83. Chemical engineering graduates had 81% or more offers (2,096 vs 1156) and offers to BS chemists increased 31.3% (198 vs 147). Among new PhDs, increases reported were 31.7% (282 vs 214) for chemists and 101% (163 vs 81) for chemical engineers.

Also encouraging is an increase in the volume of help wanted advertisements reported by Chemical and Engineering News. Comparing the second quarter of 1984 with that of 1983, C&EN showed a 77% increase, suggesting that the improving trend in employment captured in this survey in March, 1984 will continue.

POST-GRADUATION EMPLOYMENT STATUS: 1983-84 Graduates

Although starting salaries are somewhat higher than last year, the percent of 1983-84 graduates that were still looking for jobs at the time of this survey still remains high, showing declines for both chemists and chemical engineers only in relation to the severe employment situation of 1983.

Unemployment of recent BS graduates is less severe in chemistry this year than it is in chemical engineering, but even in chemistry the problem is worse than the figures in Table 3.1.2 seem to indicate. To understand the extent of unemployment among new chemistry graduates requires an additional calculation. Because unemployment is defined as a fraction of the labor force, persons not seeking work (the majority of BS chemistry graduates) are neither employed nor unemployed. An accurate reading of unemployment requires removing two groups not seeking employment from the denominator of the unemployment rate: graduates who plan to attend graduate school and those not seeking full-time employment, most of whom plan to attend medical or other professional schools. Performing the calculation in this way yields larger unemployment rates among recipients of the bachelor's degree: 27% in chemistry and 24% in chemical engineering.

The recent history for unemployment calculated in this way is:

	1984	1983	1982	1981	1980
Chemical engineering	24%	42%	26%	8%	6%
Chemistry	27	31	21	23	22

PLANS FOR ADVANCE STUDY and POSTDOCTORAL FELLOWSHIPS

In chemistry, postdoctoral fellows as a percent of new PhDs provides a rough indicator of demand. Because some of the new doctoral chemists who accept postdoctoral fellowships would have preferred full-time employment, an increase in the fraction accepting such fellowships indicates insufficient full-time employment. This year this measure of demand indicates that the climate is slightly less hospitable than it was last year: 37.9% accepted postdoctoral positions in 1984 as compared with 33.7% in 1983.

Bachelor's degree recipients' plans for advanced study are little different from those of last year's graduates. A summary of these plans appears in Table 1.3.2.

CERTIFIED GRADUATES

"Certified graduates", i.e., graduates completing undergraduate chemistry programs approved by the ACS's Committee on Professional Training, generally received higher starting salaries than non-certified graduates. One third of all BS chemistry graduates responding to the survey planned to study medicine. More than 73 percent of those studying medicine were non-certified. The unemployment rate for certified graduates was somewhat lower (12% versus 13%) than that for non-certified graduates.

CHARACTERISTICS OF DEGREE GRANTING INSTITUTIONS AND EMPLOYERS

The 1983 Starting Salaries survey began an attempt to account for the variation in salaries paid to new bachelor's degree recipients, primarily by analyzing salary differences according to the new graduates' academic performance and the size of their employers. In 1984 we have turned out attention to the characteristics of the degree granting institutions and expanded the classification of employers so that it is possible to separate out the smaller firms (less than 500 employees) that comprise the majority of chemical companies listed by Dun and Bradstreet (7,032 out 7,948: approximately 88%). These firms are the employers of 35% of the new employees with the BS in chemistry and 17% of the newly employed BS chemical engineers.

The type and size of the school from which new BS graduates received their degrees was more variable for chemists than for chemical engineers. Because graduates of some type of schools received higher starting salaries than others, variability had the effect of widening the range of chemists' starting salaries. Generally speaking, graduates received more if their degree was from a school that had one or more of the following characteristics: (a) large (b) granted graduate degrees and (c) was privately controlled.

The greater variability among chemists' median salaries is also seen in comparisons of employing firms ranked by the number of employees. The range of chemists' median salaries was 25% compared to a 17% range for the chemical engineers. As we noted above, proportionally more chemists than chemical engineers took employment in firms with less than 500 employees. Because those firms offered a lower median starting salary than larger ones, proportionally more chemists were clustered at the lower end of the salary range.

We suggest that these differences ought to be taken into account, along with more obvious ones, when comparing salaries.

EMPLOYMENT TRENDS IN CHEMISTRY AND CHEMICAL ENGINEERING : 1980-1984*

John Robert Jones and Terrence R. Russell

Statistics about employment among chemists and chemical engineers are taken from two annual studies conducted by ACS Statistical Services. The first of these is a survey that gathers information from new graduates in chemistry and in chemical engineering, providing data on employment at this crucial step in their careers. The other annual study, a survey of ACS members, gives us a reading of employment among experienced chemists. Unfortunately, we have no comparable data for experienced chemical engineers.

Trends Among New PhD Recipients

The survey of new graduates tells where chemists and chemical engineers go after they complete a degree. First, consider new PhDs in chemistry. Their employment market has several features that make it difficult to judge the actual demand for new phDs. Unlike bachelor's degree recipients, where a useful measure of demand is the percent unemployed, PhDs have several devices that protect them from actual unemployment.

When times are tough, some new PhDs obtain jobs that otherwise might go to master's degree recipients. Others may avoid unemployment by the simple device of postponing graduation and continuing to be graduate assistants for a while longer. Finally, doctoral recipients who would prefer permanent jobs sometimes accept post-doctoral fellowships as a second choice.

The percentage of postdoctoral fellows provides a measure of how well the market absorbs new PhDs. Of course, a certain fraction take "postdocs" as their first choice because these fellowships provide the best opportunity to gain experience doing the particular kind of research they have chosen for their career. On the other hand, some who might otherwise prefer to obtain postdoctoral experience will to be lured directly into industrial employment in extraordinarily good times. Despite these ambiguities we can roughly estimate what fraction of new PhDs consider a post doctoral fellowship their first choice. Table 3.1.1 shows that during the past 11 years, postdoctoral fellows have been no less than about one-fourth of graduates.

It is reasonable to conclude that at most, shifts in the employment market will afffect the number of people taking postdoctoral study only to the extent that the fraction of such people exceeds 25%.

The moderate increases in that fraction in 1982 (when it went from 29% to 31%) and in 1983 (when it went further to 34%) suggest that times were getting tougher. As Table 3.1.1 indicates, recent years have not been as bad as the middle 1970s, when about half of new PhDs took postdoctoral positions.

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*An earlier version of this article appeared in the ACS Professional Relations Bulletin No. 34, October, 1984.

Trends in chemical engineering differ strikingly from those in chemistry. An employment market that was very hospitable to new ChEs during the late 1970's and early 1980's changed dramatically in 1983. Still, only one in eight of new doctoral ChEs took a postdoctoral fellowship indicating the relative lack of importance of the postdoctoral fellowship in ChE careers and continuing demand for PhD ChEs.

Trends Among New B.S Degree Recipients

Turning to bachelor's degree recipients, we look first at the fraction of new graduates who had not secured employment by the time they received our questionnaire a few weeks after graduation. In 1980, 22% of the new holders of chemistry bachelor's degrees who were looking for employment were unemployed at the time of the survey. Two years later that fraction had risen to 28%, and last year it climbed still further to 31%. If entry level employment is difficult to secure for the holder of a B.S. in chemistry, then what happens to the number of these graduates going to graduate school? Table 3.1.2 shows that as employment became increasingly hard to find, graduate school was the choice of an increasing fraction of chemistry bachelor degree recipients.

As among doctoral recipients, the experience of bachelor's degree recipients in chemical engineering contrasts sharply with that of chemists. Until 1982 more than 90% of ChE bachelor's graduates had secured a graduate stipend or employment by the time of graduation. Because of this demand and high starting salaries, a tremendous number of students responded by choosing ChE as their major. Shortly after, demand for petroleum products dropped, depressing the employment market in the industry. The result was that one-fourth of ChE graduates who were looking for employment were unemployed at the time of the 1982 survey and 40% were unemployed at the time of the 1983 survey. Lack of opportunity for new chemical engineers with the bachelor's degree apparently led some to choose graduate school but it was a far smaller fraction than the B.S. chemists: 16% compared with 32% in chemistry.

Trends Among Experienced Chemists

Statistics for unemployment among experienced chemists move in step with those for new graduates. Having remained at almost exactly 1% for three years, unemployment among ACS members increased in 1982 to 1.5% and increased further in 1983 to 2.2%. The 1984 salary survey indicates that on March 1 unemployment among ACS members had decreased slightly to 1.7%.

Because unemployment is a greater problem for younger chemists who are seeking entry positions and older chemists who generally experience longer periods of unemployment than do recent graduates, we studied the age distribution of those ACS members who were unemployed on March 1, 1984 and compared that distribution with data from three recent years, 1980 to 1984 (1981 data were not available).

The age distribution of unemployed ACS members appears in Table 3.1.3. Among unemployed bachelor's degree holders the fraction less than 30 years old increased between 1980 and 1984 (from 35% to 41% of the total) while the fraction in each of the older age groups decreased (the 30-50 year-olds from 35% to 30% and those older than 50 from 31% to 29%.

Among M.S. and Ph.D. holders, those over 50 accounted for an increasing percent of the unemployed between 1980 and 1984: from 17% to 35% among master's degree holders and from 25% to 39% among Ph.Ds. Among the unemployed PhDs, the fraction in mid-career also increased between 1980 and 1984 as the fraction less than 30 years old nearly disappeared (dropping from 29% to 2%).

These figures reflect the different nature of the B.S. and Ph.D. employment markets. While entry level jobs are still the scarce ones for B.S. graduates, new Ph.Ds are finding employment in the start-up of R&D activity caused by an improving economy and, as we saw above, they have options in postdoctoral education that are increasingly popular.

The problem for older chemists was not only that they were becoming an increasing percent of those unemployed, but, as that statement implies, the duration of unemployment for chemists over 50 had increased at every degree level. The duration of unemployment[1] is an indicator of its severity and, by looking at changes in the duration of unemployment for various groups (defined by level of education or by age), we can see how rapidly (or slowly) the employment market is changing in its demand for various types of workers. Among PhDs, on March 1, 1980 the median duration of unemployment was 7 to 8 months for all three age groups. In 1984, the duration of unemployment among PhDs showed no such uniformity across age groups. The older unemployed had been unemployed substantially longer, while duration of unemployment among those under 30 had dropped drastically from 8 months to 2 months.

The trends for older chemists were similar for BS and PhD holders, increasing from 3 months to 11 months for B.S. holders and from 3 months to 9 months for M.S. holders. Among mid-career B.S. holders the duration of unemployment decreased somewhat in 1982 and 1983, but in 1984 the figures climbed back to the 1980 level of 11 months. The continuing lack of entry-level jobs in industry shows itself in the increasing duration of unemployment among BS chemists younger than 30.

In summary, the 1984 survey data indicated that the worst effects of the "1980's recession" had passed, and the rate of unemployment has decreased. Two severe problems remained. Some older chemists suffered very long periods of unemployment and many new college graduates could not get started on their careers in a reasonable amount of time.

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[1] Duration of unemployment presents some conceptual problems. In the ACS surveys, members who were unemployed on March 1 answered the question "How long have you been unemployed?" Of course, this answer does not tell us how long unemployment generally lasts. To answer that question one would have to ask people how long their spell of unemployment lasted after it has ended. Nevertheless, the data available do allow for some informative comparisons.

Post-Doctoral Fellows As a Percent of PhD Recipients: 1978-1983

	Post-Doctoral Fellows As a Percent of PhD Recipients (1)		Total Number of PhD Recipients (2)	
	Chemists	Chem. Engrs.	Chemists	Chem. Engrs.
1973	40%	12%	1872	397
1974	43	4	1823	400
1975	48	5	1822	346
1976	49	13	1621	308
1977	43	9	1568	291
1978	33	6	1521	259
1979	24	6	1516	304
1980	30	0	1545	284
1981	29	7	1622	300
1982	31	3	1708	311
1983	34	13	1680 (Est.)	320 (Est.)

(1) Source: ACS Starting Salary Surveys
(2) Source: National Center for Educational Statistics

Table 3.1.2

Unemployment Trends Among New BS Degree Recipients: 1980 - 1983

Unemployed Graduates
As a Percent of Bachelor's
Degree Recipients in the Labor Force

	Chemists	Chemical Engineers
1980	22%	6%
1981	23	8
1982	28	26
1983	31	42

Graduates in the Labor Force
As a Percent of Bachelor's Degree Recipients

	Chemists	Chemical Engineers
1980	44%	84%
1981	47	87
1982	46	86
1983	47	81

Graduate Assistants and Fellows
As a Percent of Bachelor's Degree Recipients

	Chemists	Chemical Engineers
1980	28%	12%
1981	24	9
1982	26	10
1983	32	16

Source: ACS Starting Salary Survey

Table 3.1.3

Age Distribution of Unemployed ACS Members: 1980-1984

Note: Rows may not total 100% due to rounding error.

B.S.

	Age 29 or Younger	Age 30 - 49	Age 50 or Older
1980	36.1%	40.4%	23.4%
1982	30.0	42.9	27.1
1983	35.5	41.1	23.4
1984	41.3	30.2	17.1

M.S.

	Age 29 or Younger	Age 30 - 49	Age 50 or Older
1980	38.5%	42.3%	19.2%
1982	16.6	56.6	26.6
1983	13.8	48.3	37.9
1984	31.0	34.5	34.5

PhD

	Age 29 or Younger	Age 30 - 49	Age 50 or Older
1980	5.0%	55.0%	40.0%
1982	6.6	60.7	32.8
1983	5.3	59.6	35.1
1984	2.0	58.8	39.2

Table 3.1.4

SCIENTISTS AND ENGINEERS BY FIELD AND RACE: TOTAL POPULATION: 1982

Field	*Total*[1]	*White*	*Black*	*Asian*	*Native American*
	Total population				
Total S/E	3,588,500	3,278,200	92,800	160,900	14,200
Total scientists	1,608,000	1,472,400	49,700	59,800	6,000
Physical scientists	248,700	228,400	6,500	10,400	600
Chemists	171,600	155,500	5,800	8,400	500
Physicists/astronomers	49,700	46,800	500	1,400	100
Other physical scientists	27,400	26,100	200	600	(2)
Mathematical scientists	49,200	37,400	3,000	7,600	(2)
Mathematicians	32,100	25,100	1,900	4,200	(2)
Statisticians	17,100	12,400	1,100	3,500	(2)
Computer specialists	395,800	366,100	9,700	14,700	1,200
Environmental scientists	93,900	87,400	600	3,800	700
Earth scientists	79,000	73,900	500	2,900	500
Oceanographers	3,900	3,400	100	100	200
Atmospheric scientists	11,000	10,100	(2)	800	(2)
Life scientists	380,200	358,700	8,500	8,600	1,200
Biological scientists	268,200	252,400	6,800	6,000	600
Agricultural scientists	82,200	78,000	1,400	1,700	600
Medical scientists	29,800	28,400	300	800	(2)
Psychologists	156,000	146,600	5,200	1,700	1,000
Social scientists	284,100	247,700	16,200	13,000	1,200
Economists	123,200	107,900	4,700	8,300	700
Sociologists/ anthropologists	67,300	57,700	5,500	1,600	400
Other social scientists	93,600	82,200	5,900	3,100	100
Engineers	1,980,500	1,805,800	43,000	101,100	8,300

1. Includes racial categories listed as well as Other and No Report.
2. Too few cases to estimate.

NOTE: Detail may not add to totals because of rounding. These are preliminary data, subject to revision.

SOURCE: National Science Foundation, Unpublished data.

Table 3.1.5

SCIENTISTS AND ENGINEERS BY FIELD, RACE: TOTAL EMPLOYED: 1982

Field	Total[1]	White	Black	Asian	Native American
	Total employed				
Total S/E	3,328,500	3,040,000	86,400	149,900	13,500
Total scientists	1,488,900	1,364,700	46,200	54,800	5,700
Physical scientists	225,100	207,400	5,700	9,200	500
Chemists	154,200	140,300	5,100	7,300	400
Physicists/astronomers	45,800	43,300	500	1,300	100
Other physical scientists	25,100	23,800	200	600	(2)
Mathematical scientists	44,600	33,900	2,700	6,900	(2)
Mathematicians	29,100	22,600	1,600	4,000	(2)
Statisticians	15,500	11,300	1,100	2,900	(2)
Computer specialists	382,200	353,600	9,500	14,200	1,200
Environmental scientists	85,700	79,700	500	3,600	700
Earth scientists	72,400	67,600	400	2,800	500
Oceanographers	3,300	2,900	(2)	100	200
Atmospheric scientists	10,000	9,200	(2)	700	(2)
Life scientists	350,900	331,000	8,100	8,000	1,100
Biological scientists	246,400	231,700	6,400	5,500	600
Agricultural scientists	75,700	71,900	1,300	1,600	400
Medical scientists	28,900	27,400	300	800	(2)
Psychologists	144,200	135,800	4,800	1,400	900
Social scientists	256,000	223,400	14,900	11,400	1,200
Economists	112,100	98,200	4,500	7,400	700
Sociologists/ anthropologists	61,000	52,500	5,200	1,500	400
Other social scientists	82,900	72,700	5,200	2,600	100
Engineers	1,839,600	1,675,300	40,200	95,100	7,900

1. Includes racial categories listed as well as Other and No Report.
2. Too few cases to estimate.

NOTE: Detail may not add to totals because of rounding. These are preliminary data, subject to revision.

SOURCE: National Science Foundation, Unpublished Data.

Table 3.1.6

SCIENTISTS AND ENGINEERS BY FIELD, RACE: EMPLOYED IN SCIENCE AND ENGINEERING: 1982

Field	*Total*[1]	*White*	*Black*	*Asian*	*Native American*
			S/E employed		
Total S/E	2,901,800	2,650,800	71,800	135,000	11,100
Total scientists	1,196,100	1,097,900	34,800	45,600	4,300
Physical scientists	206,700	191,600	4,900	8,000	500
Chemists	140,900	129,000	4,500	6,100	400
Physicists/astronomers	42,900	40,700	300	1,300	100
Other physical scientists	22,900	21,800	200	600	(2)
Mathematical scientists	40,400	31,000	2,500	6,200	(2)
Mathematicians	26,500	20,700	1,500	3,600	(2)
Statisticians	13,900	10,300	1,000	2,600	(2)
Computer specialists	272,300	250,900	6,600	11,000	800
Environmental scientists	80,700	74,900	400	3,500	700
Earth scientists	68,200	63,600	300	2,800	500
Oceanographers	2,900	2,600	(2)	100	200
Atmospheric scientists	9,600	8,700	(2)	700	(2)
Life scientists	308,600	291,500	7,400	6,600	800
Biological scientists	219,500	206,400	5,900	5,100	400
Agricultural scientists	64,000	61,300	1,200	900	300
Medical scientists	25,100	23,800	300	700	(2)
Psychologists	108,600	103,400	2,600	1,000	500
Social scientists	178,800	154,700	10,400	9,200	1,000
Economists	81,100	69,000	3,900	6,400	600
Sociologists/ anthropologists	40,300	35,500	2,500	1,200	200
Other social scientists	57,400	50,200	4,000	1,600	100
Engineers	1,705,700	1,553,000	37,000	89,300	6,800

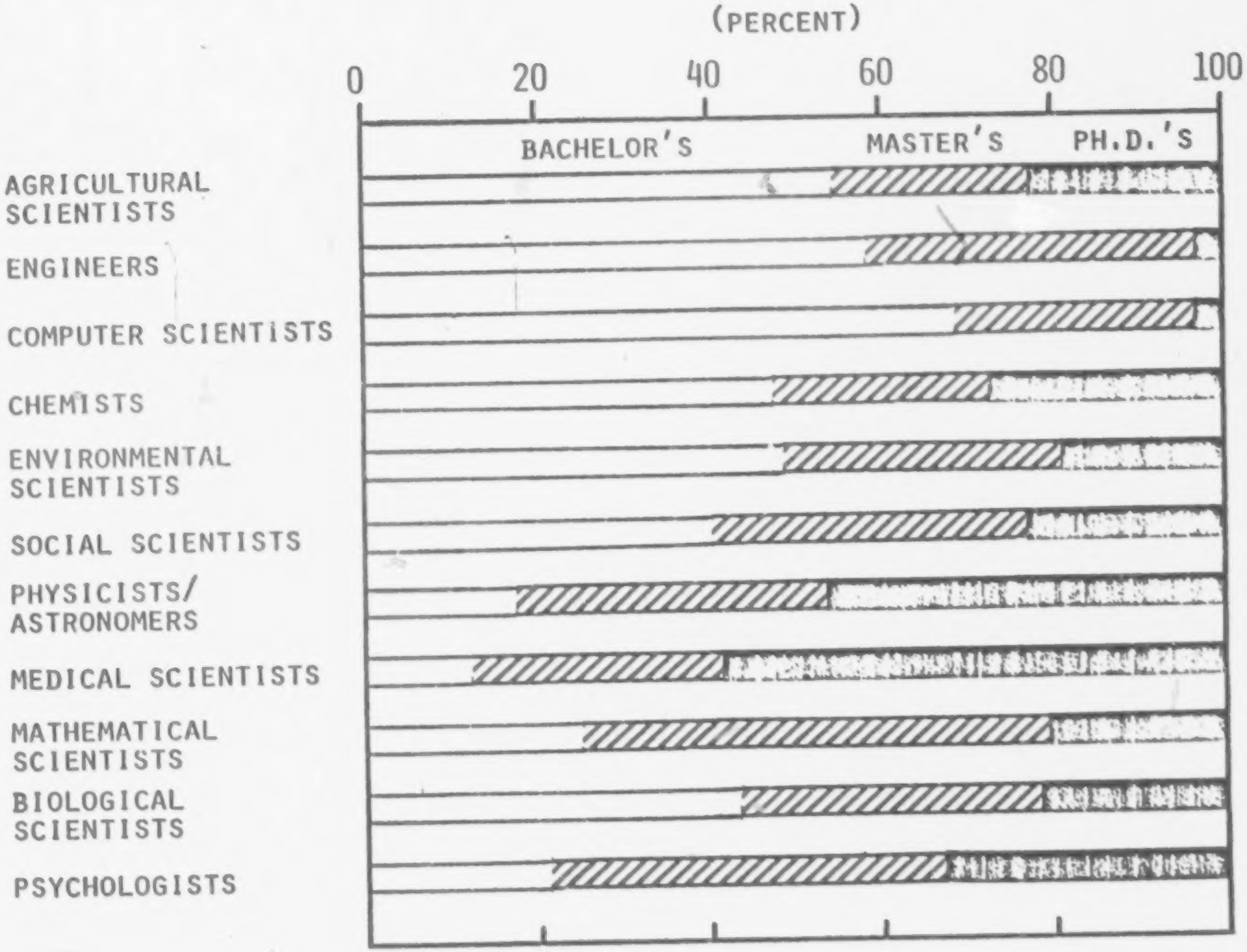
1. Includes racial categories listed as well as Other and No Report.
2. Too few cases to estimate.

NOTE: Detail may not add to totals because of rounding. These are preliminary data, subject to revision.

SOURCE: National Science Foundation, Unpublished data.

Figure 3.1.7

HIGHEST DEGREE LEVEL OF SCIENTISTS AND ENGINEERS IN 1982



Source: National Science Foundation

Reprinted from Opportunities in Science and Engineering, Scientific Manpower Commission, 1984.

Table 3.1.8

Doctorate Recipients Entering the U.S. Labor Force by Citizenship and Field of Study, 1959-1983 (Includes Those on Post-Doctoral Fellowships)

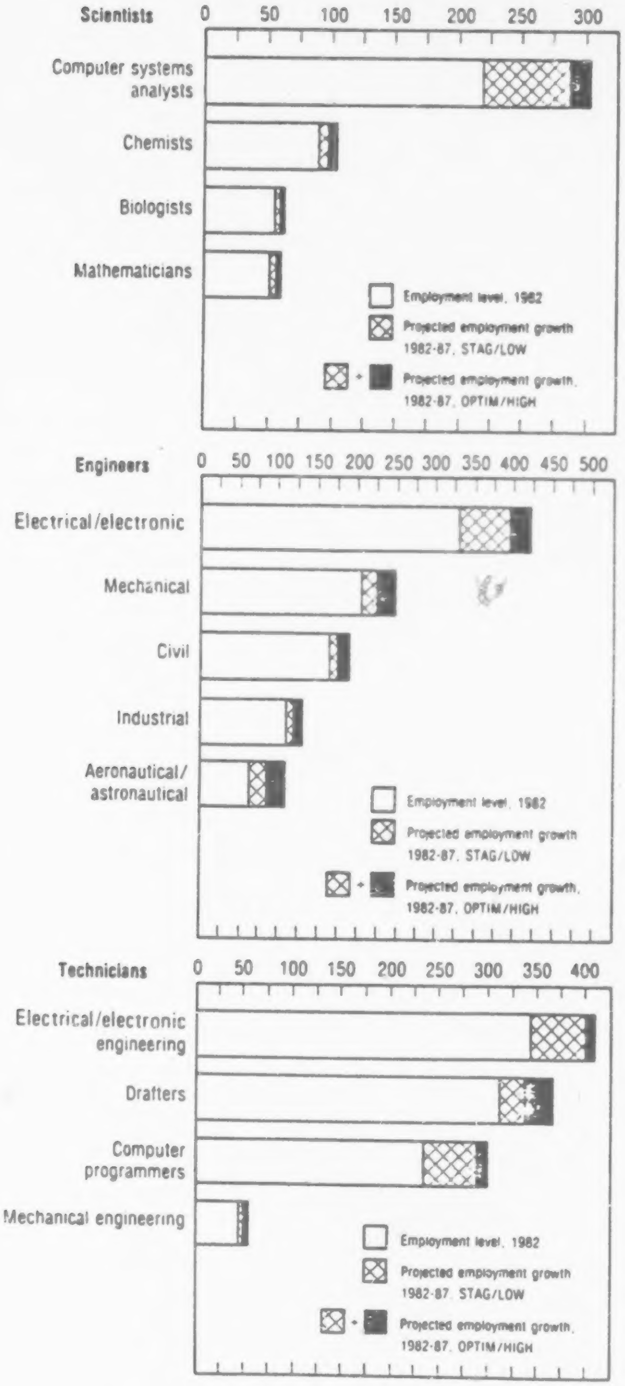
Citizenship Status	Year of Doctorate												
	1959	1961	1963	1965	1967	1969	1971	1973	1975	1977	1979	1981	1983
Total All Fields	9,213	10,413	12,728	16,340	20,403	25,743	31,867	33,755	32,951	31,717	31,237	31,345	31,190
Total, U.S. Location	8,517	9,520	11,678	14,922	18,875	23,833	29,254	31,189	30,508	29,440	28,946	28,925	28,716
U.S. Citizens	92.0	91.1	90.8	89.6	88.1	88.0	88.4	87.2	86.6	86.8	86.3	84.8	82.9
Non-U.S. Perm. Visas	3.2	2.2	2.3	2.9	3.6	4.3	5.7	5.9	5.2	4.3	4.3	4.2	4.1
Non-U.S. Temp. Visas	3.9	5.2	5.4	6.0	6.0	5.1	4.2	4.7	6.2	6.2	6.5	7.5	9.1
Cit. Not Reported	.9	1.5	1.5	1.6	2.3	2.6	1.7	2.1	2.0	2.6	3.0	3.6	3.9
Physics and Astronomy	516	597	817	1,046	1,312	1,461	1,738	1,589	1,300	1,150	1,108	1,015	1,042
Total, U.S. Location	473	538	748	954	1,209	1,325	1,524	1,436	1,176	1,044	1,010	925	922
U.S. Citizens	87.5	86.4	85.4	85.2	82.5	85.1	82.3	79.5	75.5	76.3	76.4	73.4	72.3
Non-U.S. Perm. Visas	4.2	2.4	2.7	3.2	5.0	4.2	7.1	7.8	8.5	7.6	6.5	5.6	5.1
Non-U.S. Temp. Visas	6.6	8.6	9.6	9.6	9.1	7.2	7.7	10.9	14.1	13.9	14.1	16.9	19.7
Cit. Not Reported	1.7	2.6	2.3	1.9	3.4	3.5	2.9	1.9	1.9	2.2	3.0	4.1	2.8
Chemistry	1,054	1,150	1,288	1,444	1,773	1,967	2,211	1,855	1,776	1,571	1,566	1,612	1,759
Total, U.S. Location	980	1,073	1,203	1,335	1,643	1,841	2,000	1,728	1,652	1,481	1,481	1,517	1,648
U.S. Citizens	91.5	88.0	88.3	88.2	86.6	86.8	85.6	81.1	80.6	81.5	81.7	78.9	79.4
Non-U.S. Perm. Visas	2.8	2.7	1.8	2.5	3.0	4.7	7.8	10.0	7.4	6.8	6.3	6.1	4.1
Non-U.S. Temp. Visas	5.2	8.0	7.8	8.5	9.2	6.6	5.4	6.9	9.3	9.8	10.5	12.1	13.4
Cit. Not Reported	.5	1.3	2.1	.9	1.2	2.0	1.4	1.9	2.6	2.0	1.6	2.9	3.1
Mathematics	289	332	483	685	830	1,070	1,238	1,232	1,147	933	769	728	701
Total, U.S. Location	271	305	451	639	783	999	1,150	1,100	1,033	852	708	650	619
U.S. Citizens	88.2	87.2	86.7	88.6	85.3	86.7	85.6	82.5	80.1	79.7	76.7	72.8	65.4
Non-U.S. Perm. Visas	3.3	2.3	2.0	2.2	3.1	4.5	5.1	6.7	7.0	6.3	6.9	6.2	6.8
Non-U.S. Temp. Visas	6.3	7.5	9.3	6.9	9.3	7.0	8.3	8.4	10.4	11.4	14.0	18.8	22.3
Cit. Not Reported	2.2	3.0	2.0	2.3	2.3	1.8	1.0	2.4	2.6	2.6	2.4	2.3	5.5
Engineering	699	940	1,357	2,074	2,604	3,265	3,498	3,364	3,002	2,643	2,490	2,528	2,780
Total, U.S. Location	643	883	1,238	1,891	2,419	3,054	3,147	3,030	2,713	2,392	2,214	2,220	2,391
U.S. Citizens	80.7	81.9	83.4	82.0	79.3	77.6	74.9	69.5	61.9	60.6	57.2	52.0	47.7
Non-U.S. Perm. Visas	9.2	5.3	5.0	5.6	7.6	10.1	15.1	17.1	15.1	13.2	14.1	13.2	12.8
Non-U.S. Temp. Visas	9.6	12.1	10.5	10.3	11.5	10.1	9.0	12.0	21.0	23.2	26.0	29.7	34.2
Cit. Not Reported	.5	.7	1.1	2.1	1.6	2.3	1.0	1.4	2.0	3.0	2.7	5.1	5.4
Biological and Health Sciences	1,239	1,345	1,617	2,108	2,537	3,389	4,195	4,134	3,959	3,995	4,214	4,457	4,368
Total, U.S. Location	1,092	1,148	1,427	1,814	2,280	3,053	3,825	3,801	3,629	3,708	3,896	4,136	4,075
U.S. Citizens	90.3	87.7	88.3	86.5	86.1	87.2	87.4	86.5	86.2	86.5	88.4	89.1	87.9
Non-U.S. Perm. Visas	3.8	2.7	2.5	3.0	3.7	4.2	5.5	6.8	5.9	5.4	4.1	3.6	3.4
Non-U.S. Temp. Visas	5.5	8.2	8.8	9.5	8.5	7.1	4.6	4.5	5.3	5.3	4.6	4.7	6.0
Cit. Not Reported	.5	1.4	.4	.9	1.7	1.5	2.5	2.2	2.6	2.8	2.9	2.6	2.8

NOTE: Details may not add to totals because of rounding.

Source: Summary Report 1983: Doctorate Recipients, National Research Council

Table 3.2.1

Projected Employment in Major Science, Engineering, and Technician Occupations: 1982-87



NOTE: STAG/LOW indicates the low-economic growth/low-defense spending scenario and OPTIM/HIGH indicates the high-economic growth/high-defense spending scenario

Source: National Science Foundation. Special Report NSF 84-304

Table 3.2.2

PROJECTED EMPLOYMENT IN SCIENCE OCCUPATIONS: 1982-87
(In Thousand)

Occupation	1982 employment	Projected employment			
		STAG/LOW		OPTIM/HIGH	
		1987 employment	Annual growth rate (percent)	1987 employment	Annual growth rate (percent)
Total scientists	727	843	3.0	888	4.1
Agricultural	17	17	.1	18	1.4
Biologists	55	59	1.4	62	2.4
Chemists	91	98	1.5	103	2.5
Computer systems analysts	219	287	5.6	303	6.7
Geologists	43	48	2.3	48	2.3
Life and physical, n.e.c.	28	30	1.3	31	2.5
Mathematical	51	57	2.2	61	3.5
Physicists	21	22	1.4	24	3.0
Social	202	225	2.2	237	3.2
Economists	30	35	2.8	36	3.6
Psychologists	90	100	2.1	106	3.2
Sociologists	9	10	1.7	11	2.8
Social, n.e.c.	72	79	1.9	84	3.0

NOTES: Because of rounding, components may not correspond to totals. STAG/LOW indicates low-economic growth/low-defense expenditure scenario; OPTIM/HIGH indicates high-economic growth/high-defense expenditure scenario.

SOURCE: National Science Foundation. Special Report NSF 84-304

Table 3.2.3

PROJECTED GROWTH RATES OF DEFENSE AND NONDEFENSE EMPLOYMENT IN MAJOR SET OCCUPATIONS:

1982-87
(Percent)

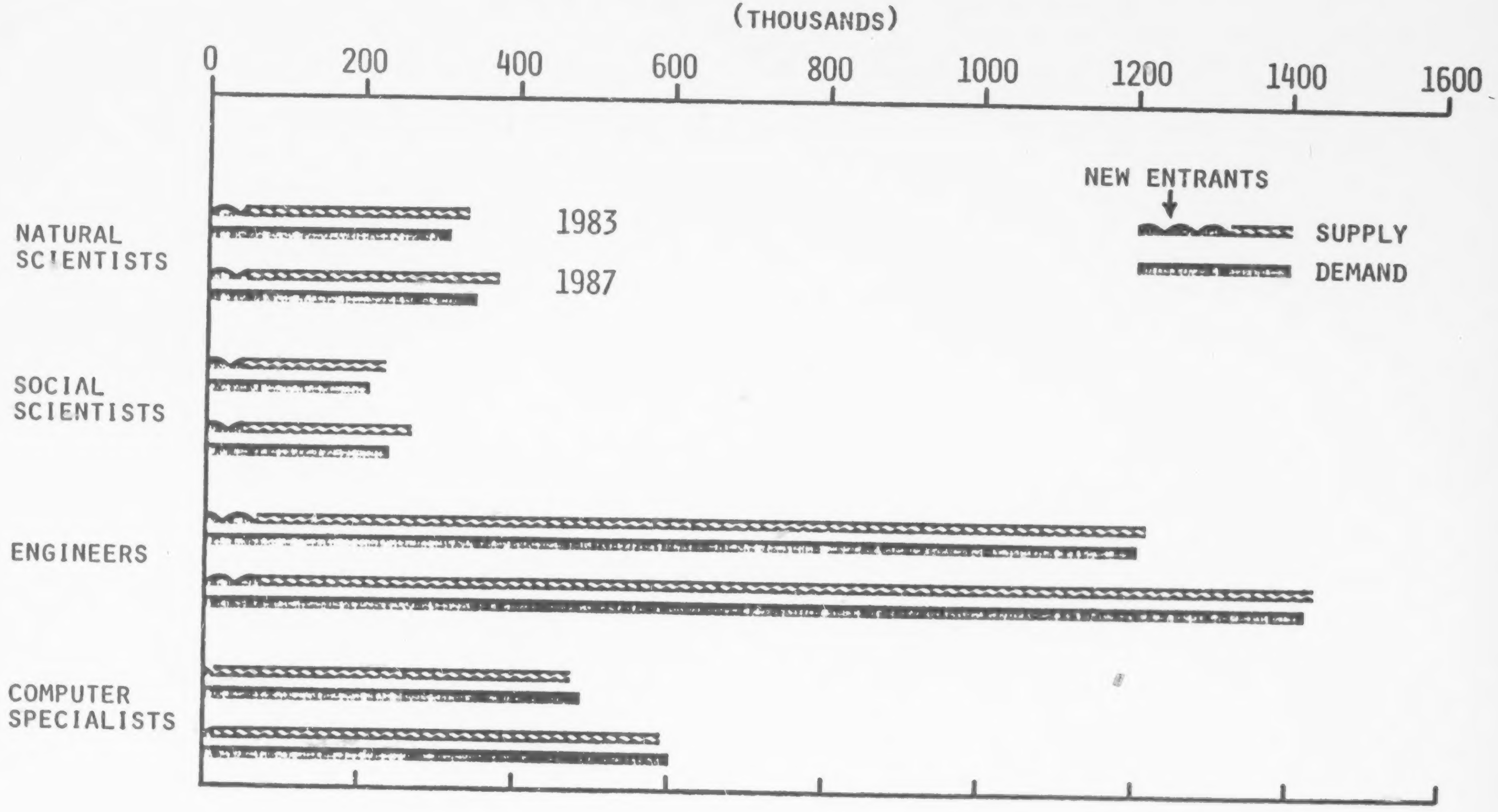
Occupation	STAG/LOW		OPTIM/HIGH	
	Defense employment	Nondefense employment	Defense employment	Nondefense employment
Total scientists	6.1	2.9	9.2	3.9
Chemists	4.0	1.4	5.5	2.4
Computer systems analysts	8.9	5.4	12.3	6.4
Life and physical, n.e.c.	5.1	1.3	9.5	2.4
Mathematical	3.1	2.1	7.8	3.3
Physicists	3.4	1.2	7.9	2.6
Total engineers	6.1	2.1	10.2	3.6
Aeronautical/ astronautical	8.5	2.7	14.1	7.3
Electrical/ electronic	6.4	3.5	9.0	4.5
Industrial	5.0	1.6	9.0	3.0
Mechanical	5.4	1.7	9.5	3.5
Total technicians	5.0	2.2	8.0	3.4
Computer programmers	6.1	4.2	8.4	4.8
Electrical/ electronic engineering	5.7	2.7	8.4	3.6
Industrial engineering	4.0	1.6	8.1	3.2
Mechanical engineering	5.2	1.8	10.1	3.7

NOTE: STAG/LOW indicates low-economic growth/low-defense expenditure scenario; OPTIM/HIGH indicates high-economic growth/high-defense expenditure scenario.

Source: National Science Foundation. Special Report NSF 84-304

Figure 3.2.4

SUPPLY AND DEMAND FOR SCIENTISTS AND ENGINEERS, 1983 AND 1987



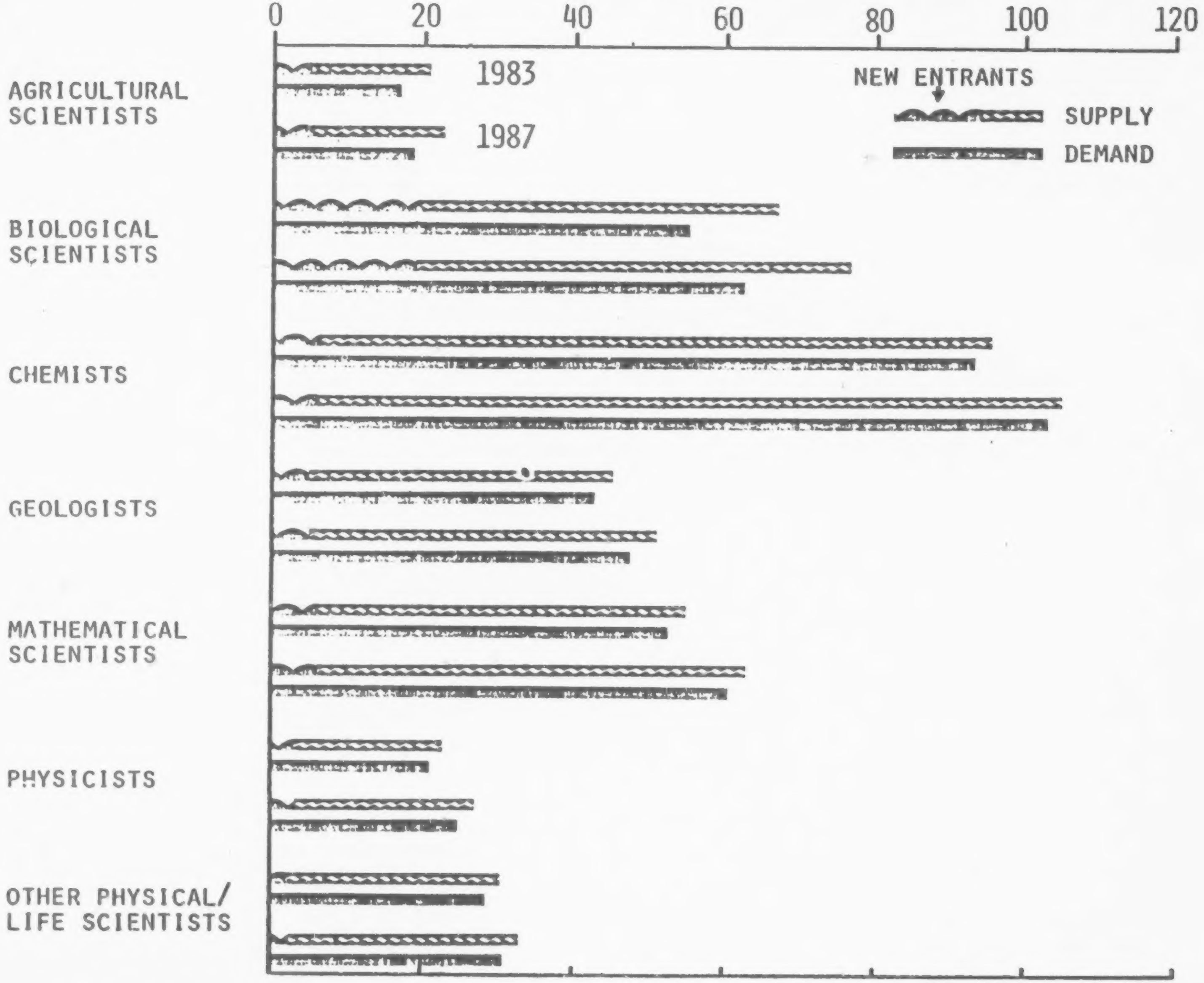
SOURCE: National Science Foundation

Reprinted from Opportunities in Science and Engineering, Scientific Manpower Commission, 1984

Figure 3.2.5

SUPPLY AND DEMAND FOR NATURAL SCIENTISTS, 1983 AND 1987

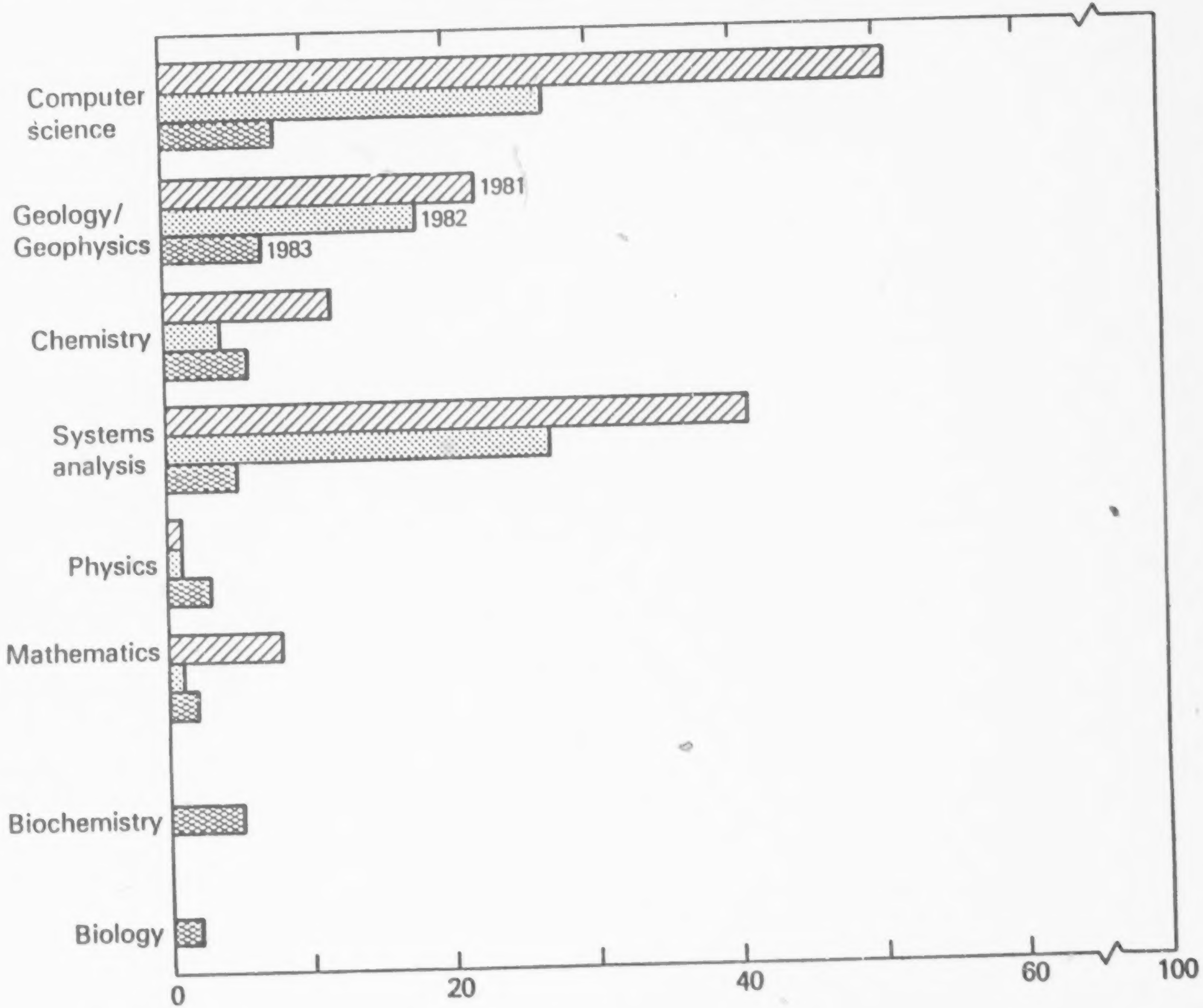
(THOUSANDS)



Source: National Science Foundation
Reprinted from Opportunities in Science and Engineering, Scientific Manpower Commission, 1984

Figure 3.2.6

PERCENT OF FIRMS REPORTING SHORTAGE OF SCIENTISTS



Source: Division of Science Resources Studies/STIA.

Reprinted from Opportunities in Science and Engineering, Scientific Manpower Commission, 1984

Table 3.2.7

Projected Demand/Supply Balance in Science/ Engineering Occupations: 1987

Occupation	STAG/LOW	OPTIM/HIGH
Scientists		
Agricultural	No shortage	No shortage
Biologists	No shortage	No shortage
Chemists	No shortage	No shortage
Computer specialists[1]	Shortage	Shortage
Geologists	No shortage	No shortage
Mathematicians	No shortage	No shortage
Physicists	No shortage	No shortage
Social	No shortage	No shortage
Engineers		
Aeronautical/ astronautical	Shortage	Shortage
Chemical	No shortage	No shortage
Civil	No shortage	No shortage
Electrical/electronic	No shortage	Potential shortage
Industrial	No shortage	No shortage
Mechanical	No shortage	No shortage
Metallurgical	No shortage	No shortage
Mining/petroleum	No shortage	No shortage
Engineering, n.e.c.	No shortage	No shortage

[1] Includes both computer systems analysts and programmers.

NOTES: Shortage occupations have projected supply estimates which deviate from projected demand by 10 percent or more; potential shortage occupations have a projected supply of workers deviating from the projected level of demand by 5 to 10 percent.

STAG/LOW indicates the low-economic growth/low-defense spending scenario and OPTIM/HIGH indicates the high-economic growth/high-defense spending scenario.

Source: National Science Foundation. Special Report NSF 84-304

Table 3.2.8

SUPPLY/DEMAND BALANCE OF SCIENTISTS AND ENGINEERS BASED ON A NET-MOBILITY SUPPLY MODEL, 1983 AND 1987

	1983				1987			
OCCUPATION	TOTAL SUPPLY	NEW ENTRANTS	DEMAND	BALANCE AS PERCENT OF SUPPLY	TOTAL SUPPLY	NEW ENTRANTS	DEMAND	BALANCE AS PERCENT OF SUPPLY
	(In thousands)							
Total Scientists	**566.2**	**87.0**	**523.0**	**7.7**	**639.9**	**92.2**	**584.7**	**8.6**
Agricultural Scientists	20.8	5.3	17.6	15.4	22.2	5.0	18.4	17.1
Biologists	67.6	19.2	56.7	16.1	76.3	19.7	62.5	18.1
Chemists	95.5	6.1	93.9	1.7	104.6	6.4	102.8	1.7
Geologists	45.7	4.4	42.5	7.0	51.6	4.9	47.9	7.2
Mathematical Scientists	55.3	5.8	53.0	4.2	63.0	5.9	60.6	3.8
Physicists	23.6	2.9	21.7	8.1	26.6	3.1	24.2	9.0
Other Life & Physical Scientists	30.1	1.9	28.6	5.0	33.3	2.0	31.3	6.0
Social Scientists	227.6	41.4	209.0	8.2	262.3	45.2	237.0	9.6
Economists	34.7	7.5	31.4	9.5	40.7	8.2	36.2	11.1
Psychologists	98.4	12.9	92.7	5.8	113.6	14.3	106.2	6.5
Sociologists	12.5	6.1	9.6	23.2	25.2	7.3	10.7	29.6
Social, n.e.c.	82.0	14.9	75.3	8.2	92.8	15.4	83.9	9.6
Total Engineers	1,217.2	64.0	1,207.6	0.8	1,437.3	66.8	1,423.1	1.0
Aero/Astronautical	70.0	1.9	72.4	-3.4	104.8	2.2	109.2	-4.2
Chemical	58.0	5.5	55.4	4.5	64.2	5.4	60.9	5.1
Civil	171.6	10.2	171.5	0.1	190.1	10.2	188.9	0.6
Electrical/Electronic	347.9	14.0	348.9	-0.3	421.3	15.6	420.6	0.2
Industrial	114.2	4.0	114.9	-0.6	129.8	4.1	130.8	-0.8
Mechanical	217.9	11.4	214.3	1.7	253.4	11.7	248.2	2.1
Metallurgical	16.3	1.4	15.8	3.1	19.2	1.4	18.5	3.6
Mining/Petroleum	28.5	2.1	27.6	3.2	32.5	2.3	31.6	2.8
Engineers, n.e.c.	192.8	13.5	186.8	3.1	222.0	13.9	214.4	3.4
Computer Specialists*	**477.7**	**10.8**	**486.9**	**-1.9**	**592.8**	**13.5**	**603.8**	**-1.9**

* Includes both computer systems analysts and computer programmers

Note: This projection is based on the high-economic growth and high-defense expenditure scenario. Because of rounding, components may not correspond to totals.

Source: National Science Foundation

Reprinted from Opportunities in Science and Engineering, Scientific Manpower Commission, 1984

Table 3.2.9

COMPARISONS OF PROJECTED JOB OPENINGS WITH PROJECTED DEGREES IN SCIENCE AND ENGINEERING 1978-1990

FIELD	Job Openings, 1978-1990 (in thousands): Senario				Graduates, 1978-1990 (in thousands): Level	
	Baseline Assumptions	Accelerated Defense Spending	Synthetic Fuels Program	Balanced Federal Budget	Bachelor's Degrees	Master's Degrees
Life and Physical Scientists						
Agricultural	16	16	16	16	193	34
Atmospheric	5	5	5	5	5	4
Biological	38	38	38	37	637	78
Chemical	63	64	64	63	178	26
Geological	22	22	23	22	67	18
Marine	2	2	2	2	10	3
Physics and Astronomy	11	11	11	11	45	19
Total	157	159	157	156	1,135	182
Mathematical Sciences						
Mathematicians	3	3	3	3	102	27
Statisticians	19	19	19	19	3	5
Total	22	22	22	22	105	32
Computer Professionals						
Programmers	300	302	300	299	NA	NA
Systems Analysts	221	223	221	221		
Other	28	29	28	28		
Total	549	553	550	547	110	47
Social Scientists						
Psychologists	76	76	76	75	490	111
Other[1]	100	102	101	99	628	58
Total	176	178	177	175	1,117	170
Engineers						
Aeronautical	24	35	24	24	28	NA
Chemical	22	22	22	21	92	
Civil	95	95	95	94	134	
Electrical	121	128	121	120	172	
Industrial	94	98	94	93	48	
Mechanical	89	95	89	89	171	
Metallurgical	9	9	9	9	16	
Mining	7	7	7	7	11	
Petroleum	11	11	11	11	14	
Other	59	61	59	59	115	
Total	528	561	534[2]	525	928[3]	196
Total All Fields	1,432	1,473	1,439	1,424	3,395	626

[1] Includes economists, political scientists and sociologists.
[2] Includes 4,000 engineers who are not distributed by field.
[3] Includes 128,000 engineering technology degrees not distributed by field.

NOTE: Estimates of openings do not include academic employment. Detail may not add to totals because of rounding.

SOURCES: National Science Foundation, Bureau of Labor Statistics and National Center for Education Statistics.

Reprinted from Opportunities in Science and Engineering, Scientific Manpower Commission, 1984

CHAPTER IV

CHEMISTRY R & D FUNDING

FEDERAL SUPPORT FOR R&D AND INNOVATION

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Current economic problems have drawn attention to the potential benefits that increased innovation, the introduction of new products and processes, could bring to the U.S. economy. More rapid rates of innovation could boost productivity growth, improve the international competitiveness of American industry, and provide the new industries needed to offset the poor growth prospects of mature sectors.

THE GOVERNMENT'S ROLE IN IMPROVING INNOVATION

The innovation process is too complex to be amenable to direct government action. Instead, the government seeks to foster innovation by establishing conditions conducive to innovative activity, an effort that combines two aspects:

- The government funds roughly half of the research and development (R&D) that is carried out in the United States. Although not identical with innovation, R&D provides the scientific and technical advances needed to sustain rapid rates of innovation. The fiscal year 1985 budget request calls for close to $53 billion in total government R&D funding, up from $44.5 billion in 1984.
- The government shapes the environment in which the private sector makes decisions about its own R&D and about the innovations it will pursue. This environment comprises overall macroeconomic conditions as well as the specific programs affecting private-sector innovation, such as tax incentives, antitrust restrictions, and so on.

The Government's Role in Funding R&D

The substantial government subsidies provided for research and development are justified on the grounds that the government should support R&D projects that are socially desirable but that are unlikely to be funded by private firms. The R&D needed for national defense is the outstanding example of activities for which the government assumes responsibility. As a result, defense accounts for a large and increasing share of the federal research budget. Since the rationale for government funding of defense-related R&D is relatively unproblematic (although the level and composition

Source: Federal Support for R&D and Innovation,
Congressional Budget Office, April 1984.

of such funding may be controversial), this report concentrates on the issues involved in civilian R&D funding and the general economic goal of more rapid rates of innovation.

Many of the policy choices in the innovation area depend on one's view of whether the market provides adequate incentives for private firms to fund the R&D needed to sustain rapid rates of innovation. When incentives are inadequate, it may be the government's responsibility to provide funding. How one defines the boundary between private and public responsibility shapes one's attitude toward policy proposals aimed at fostering innovation.

Traditionally, the public and private roles in civilian R&D have been defined in terms of what this report calls the "pipeline concept." According to this view, R&D is the core of the innovative process, and it comprises a continuum of basic research, applied research, and development. In essence, these categories can be described in the following terms:

- Basic research refers to scientific activities undertaken without regard to practical considerations, akin to "pure" science. Its results are generally uncertain, long-term, and unlikely to remain the property of the organization that sponsors the research. The investigations typically undertaken at university laboratories are good examples of basic research.

- Applied research denotes scientific activities that are undertaken to address practical problems rather than to expand the frontiers of knowledge. The defining difference between basic and applied research, therefore, concerns goals rather than content.

- Development refers to activities undertaken to solve the technical problems involved in bringing a new product or process into production. Engineering, rather than scientific activities, typically predominate in development.

As conventionally interpreted, these categories make up a linear process that runs from basic research through applied research to development. The process can be viewed as a pipeline: funds invested in basic research lead to new insights that can be focused by means of applied research and then commercialized through development. The pipeline concept also suggests a division of responsibilities between the public and private sectors. Commercialization (development and the steps that follow it) can for the most part be left to private industry, while the government's role is to subsidize basic research, which is too far removed from commercial considerations to receive adequate corporate support. According to the pipeline concept, government funding of basic research eventually leads to the commercial innovations that underlie improved economic performance.

Despite the widespread acceptance of the pipeline concept, the federal government has frequently funded civilian development activities, such as the projects designed to develop alternative energy sources and thus contribute to energy independence. Although such activities have received substantial funding, they remain outside the traditional interpretation of the government's role in R&D funding.

The pipeline concept and its concomitant definition of the public and private roles offer little guidance concerning the government's role in applied research. Some observers compare applied research to development and view market incentives as adequate to ensure sufficient private R&D funding. Others extend the rationale for public support of basic research to applied research as well, arguing that the private sector may underfund both forms of research.

How to define the government's role in applied research is one of the most significant questions facing policymakers seeking to increase the return on government-funded civilian R&D. Those who support a strong governmental commitment to applied research frequently question the view of the innovation process that underlies the pipeline concept, emphasizing the importance of the activities that link science and commerce.

The Government's Role in Shaping the Environment for Innovation

Regardless of the level of government R&D funding, the technological performance of the economy--the rate at which it develops and adopts innovations--depends on the actions of private firms. The government cannot dictate this process; it can only indirectly influence the innovative performance of the private sector. Some of the policies that shape the economic environment affecting R&D and innovation are listed below.

- **Macroeconomic policies.** In a growing economy, firms have increased cash flow to invest in R&D and greater confidence about the expected return to long-term and uncertain R&D projects. Macroeconomic policies that boost investment are particularly important in diffusing the innovations embodied in new capital equipment and increasing the incentives for innovation in capital-goods industries.

- **Policies affecting competition.** Competition is a strong inducement to innovation, since new technologies are an effective means of reducing costs and opening new markets. Policies that restrict competition, such as trade barriers, also reduce the incentive to innovate.

- **Tax incentives.** Besides the general tax policies that are an important component of macroeconomic policies, specific tax incentives have been implemented to encourage R&D and innovation.

- **Regulatory policies.** Government regulations can affect the rate of innovation. Environmental regulations may have required the commitment of R&D resources to pollution control rather than to productivity-enhancing projects. Antitrust regulations may keep firms from pursuing joint R&D projects that are unlikely to be undertaken by individual companies. Finally, patent policies, especially those involving rights to the results of government-funded R&D projects, also affect the rate of innovation.

- **Institutional and informational support.** The government can also influence the rate of private-sector innovation by providing information concerning technological developments and by facilitating links between business and the scientific community. The Department of Agriculture's technical support programs are a good example of such policies.

R&D, INNOVATION, AND ECONOMIC PERFORMANCE

While there are no explicit measures of innovation in the economy, proxies such as the rate of productivity growth suggest that the rate of innovation has slowed in the 1970s. The declining competitiveness of major U.S. industries, such as steel and automobile production, stems in part from a deteriorating U.S. technological advantage. Evidence indicates that even those manufacturing industries that are very technologically advanced and are net contributors to the balance of payments are losing competitive ground rather than retaining their lead over foreign producers. Since the late 1970s, however, the private sector has increased its commitment to R&D, and this may portend improved technological performance.

International competitiveness is highly correlated with R&D funding: firms that devote a small portion of their revenues to R&D tend to be poor competitors internationally, while firms that are strongly committed to R&D tend to be highly competitive in global markets. This relationship can be interpreted in two ways. Greater R&D investments may be a cause of good performance, so that increased R&D spending might improve the performance of less technology-intensive industries. Alternatively, industries that tend to be poor competitors internationally may be characterized by technologies that are played out, so that the return to R&D is low. These divergent interpretations of the close relationship between R&D and international competitiveness make it difficult to focus federal R&D policies to deal with the challenge of intensified international competition.

Government R&D spending by industry is also closely correlated with an industry's international competitiveness, which indicates that the pattern of government spending helps to shape the prospects of different industries. This correlation suggests that "low-tech" industries might benefit from some reorientation of federal R&D support by industry. Moreover, the waning competitive performance of several of the U.S. economy's "high-tech" sectors suggests possible technological weaknesses in the economy as a whole, a judgment that may warrant a reevaluation of governmental innovation policy. This problem may reflect a lack of aggressiveness on the part of U.S. manufacturers in adopting foreign innovations. It may also reflect the fact that countries like Japan and West Germany devote a significantly greater share of their gross national product (GNP) to civilian R&D. Policies that address such issues in order to improve the technological performance of key sectors of the U.S. economy could potentially alter the sectoral structure of the U.S. balance of payments. It should be pointed out, however, that reductions in the net imports of some sectors would be offset by countervailing shifts in the trade balance of other sectors.

Government efforts to improve the economy's technological performance should recognize that general conceptions of the innovation process fail to capture its industry-specific characteristics, which may be the most significant factors determining technological performance. In some cases, large firms in concentrated industries have outstanding records of innovation, while in others the same features are associated with relative technological stagnation. In many emerging industries, small firms are the source of rapid rates of innovation. In general, the record seems to show that innovation will be greatest when firms have the funds to invest in R&D--either because they are large or because they have access to capital markets--and when competition is strong. In addition, many other factors affect the technological prospects of specific industries: the extent to which basic science is carried out in related areas (in ferrous metallurgy for steel production, for instance), the size of the market, the capital-intensity of the industry, and the extent of technological competition in the industry. The interaction of these factors can determine the effectiveness of government innovation policies. For example, tax incentives that increase innovation in one industry may have little effect in an industry that lacks the basic research foundation needed for rapid rates of innovation. In the latter case, direct governmental funding of basic research may be a more appropriate policy initiative than tax incentives.

CURRENT R&D POLICIES

Since 1980, significant changes have occurred in the pattern of government R&D spending, as the Administration has reaffirmed the traditional rationale for governmental R&D funding. In the Administration's budget request for fiscal year 1985, defense-related R&D accounts for almost 70 percent of the total R&D budget--the highest share since 1962. In terms of civilian R&D, the Administration has reoriented spending towards basic research, which increased 23 percent in real terms between fiscal years 1982 and 1984. Civilian applied research and development have had their real funding cut almost in half since 1980. Cuts have been particularly severe at the Departments of Energy, Commerce, and the Interior, and at the Environmental Protection Agency (EPA)--although the EPA R&D budget was increased sharply in the 1985 budget request.

The Administration's R&D effort relies on the private sector to compensate for the government's reorientation of its civilian R&D funding away from applied research and development. The Administration has sought to elicit increased private R&D through a strong economic recovery, specific R&D incentives, and the removal of some barriers to private R&D. Since the late 1970s, private R&D spending has been quite strong, although the trend predates the change in Administration.

Recent changes in the tax laws, especially the accelerated capital recovery system (ACRS), have increased the attractiveness of investment, and this should speed the diffusion of innovations and increase the rate of innovation in capital-goods industries. ACRS's effects on R&D are complex, however, since the program reduces the relative impact of the R&D tax incentives that were in effect prior to the passage of the Economic Recovery Tax Act (ERTA) of 1981. Nevertheless, the net impact of ACRS on R&D incentives now appears to be positive.

In addition, ERTA introduced an incremental tax credit for increases in R&D expenditures. This program is scheduled to expire in 1985, and its impact is limited by several of its features. While the net impact of this program is positive, large numbers of firms are unable to make full use of the credit, either because they have limited tax liabilities (due to unprofitability or start-up status) or because the increases in their expenditures exceed the cap included in the program. The option of "expensing" labor and material costs for R&D, which has been in effect since 1954, is a more significant incentive than the incremental credit. [1]

Finally, the Administration seeks to encourage greater private-sector R&D by eliminating some of the regulatory barriers to such activity, especially at the basic research end of the R&D spectrum. This is the rationale behind efforts to relax antitrust restrictions on R&D joint ventures.

POLICY OPTIONS

Policymakers' attitudes toward specific innovation policies depend upon their view of the government's role in funding R&D and encouraging private innovation. Alternatively, this question can be defined in terms of the adequacy of incentives for private-sector R&D and innovation. Clarifying this underlying issue could place specific R&D policies on a clearer and more coherent foundation. Some specific options for improving federal R&D and innovation policies are discussed below.

R&D Funding. The effectiveness of governmental R&D funding depends on several factors: the stability of funding, the mix of R&D funding by type, the mix of R&D funding by industry, and so forth.

- The R&D budget could be appropriated for longer than a single year. Since R&D projects are both long-term and risky, short-term volatility in funding undermines the effectiveness of such projects.
- Greater attention could be paid to the mix of spending by type and particularly to the adequacy of funding for civilian applied research. Some of the savings from reductions in civilian development projects could be devoted to increased basic and applied research.
- The pattern of federal R&D support by industry could be made more explicit, so that the Congress could better decide whether adequate funding is available across the economy. Savings could be gained from tying government subsidies to matching funds from industry.

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[1] Expensing means that firms can deduct the full cost of qualified R&D expenditures in the year that the expenditures are made rather than depreciating them over a number of years.

- o Major scientific projects, such as the superconducting super collider and the manned space station proposed in the fiscal year 1985 budget request, are increasingly expensive. Their costs could be reduced by encouraging greater international cooperation in such projects.

Tax Policies. R&D tax incentives could be strengthened. One means to this end would be to extend the incremental R&D tax credit. Some changes in this program could increase its incentive effects: the amount of the credit could be raised, the base expenditure could be calculated in real terms, the cap on the allowable increase could be eliminated or made less strict, and so on. The evidence concerning the effectiveness of the incremental R&D tax credit is mixed, however, so that its extension may not generate the benefits its proponents seek.

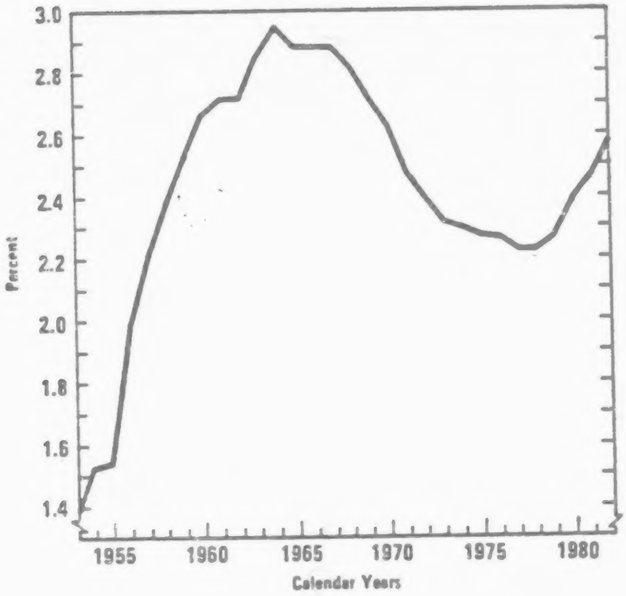
Antitrust Policies. So long as adequate safeguards for competition remain in place, relaxing antitrust restrictions for R&D joint ventures could encourage greater private support for research. Initiatives such as this may be particularly important if government funding for civilian applied research continues to be reduced.

Patent Policies. The Congress could consider supporting the Administration's efforts to grant patent rights to the firms that perform government-sponsored R&D. Evidence suggests that government retention of rights serves to retard innovation rather than to increase government revenues.

Institutional Arrangements. New institutional arrangements might be particularly important if the Congress wishes the government to play a more active role in encouraging industrial innovation. New institutional arrangements might require only limited government involvement; the Administration, for instance, is seeking to encourage closer relations between universities and industries without major government expenditures. More fundamental institutional changes could include government sponsorship, with private cooperation, of applied technology centers or the establishment of a National Technology Foundation, akin to the National Science Foundation. Both these approaches have been contained in proposed legislation. Such institutional reforms might be an appropriate vehicle for improving the government's support for applied research and for better adapting innovation policies to the specific technological needs of different industries.

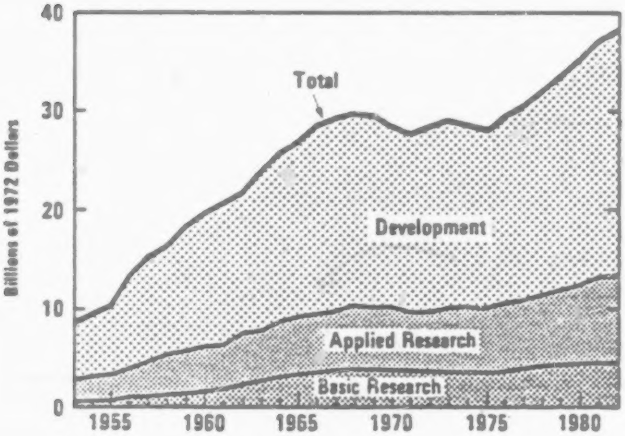
Figure 4.1.1

R&D AS A PERCENT OF GNP, 1953-1982



Source: National Science Foundation. Special Report NSF 84-304

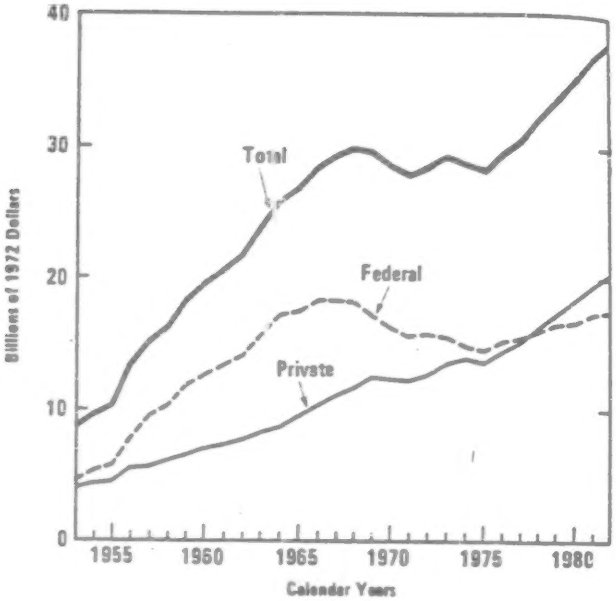
TOTAL R&D BY TYPE, 1953-1982



Source: National Science Foundation. Special Report NSF 84-304

Figure 4.1.3

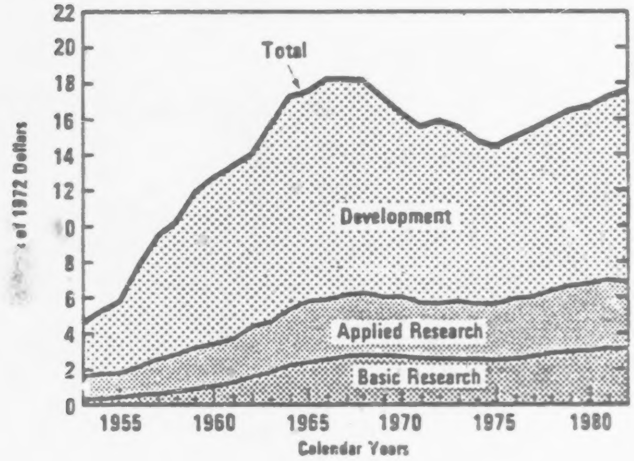
FEDERAL, PRIVATE, AND TOTAL R&D, 1953-1982



Source: National Science Foundation. Special Report NSF 84-304

Figure 4.1.4

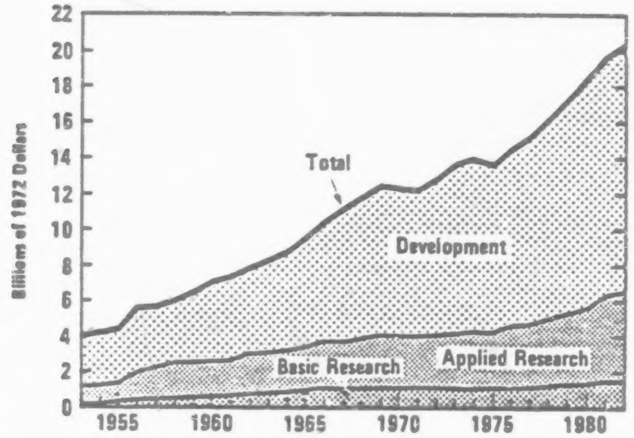
FEDERAL R&D BY TYPE, 1953-1982



Source: National Science Foundation. Special Report NSF 84-304

Figure 4.1.5

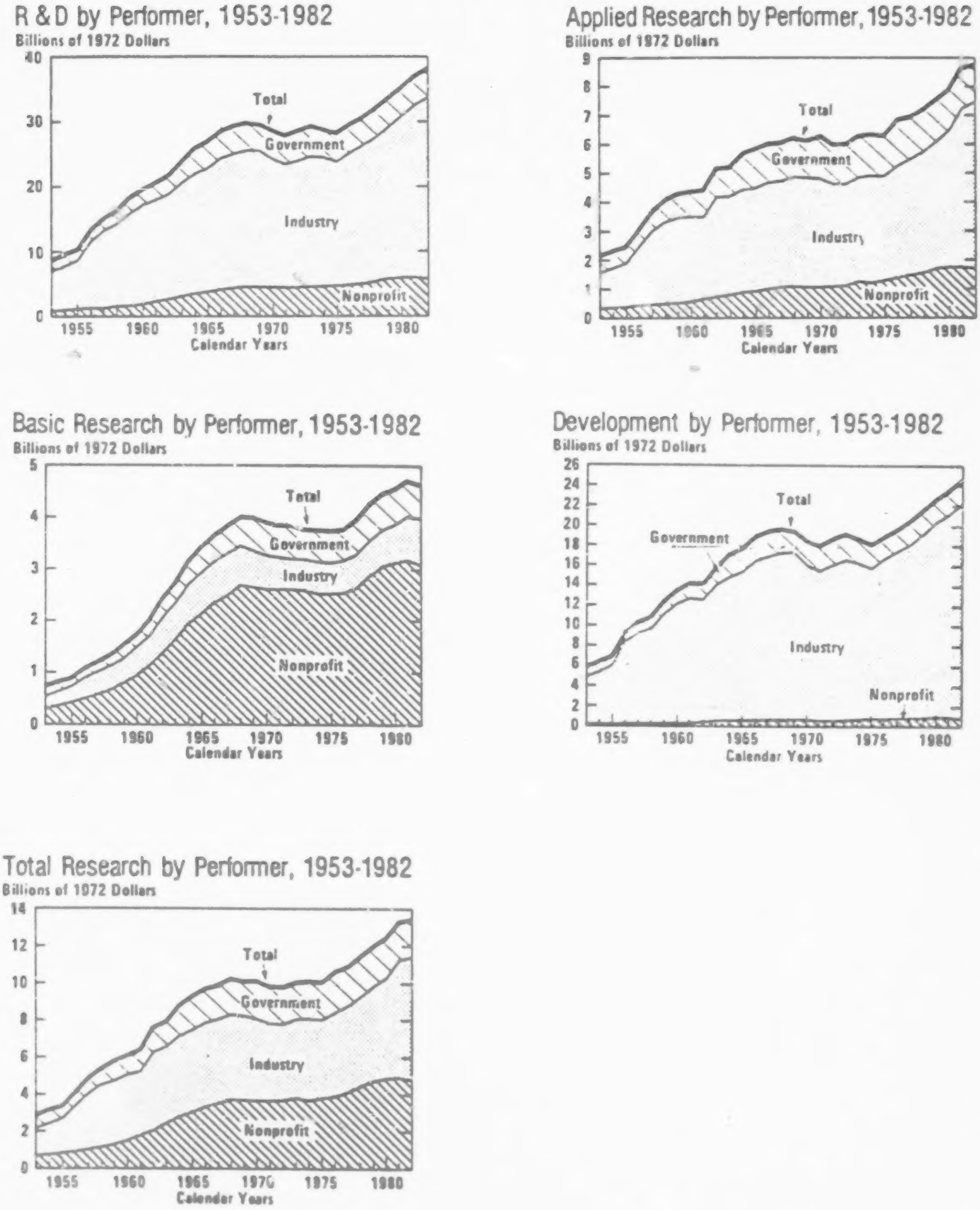
PRIVATE R&D BY TYPE, 1953-1982



Source: National Science Foundation. Special Report NSF 84-304

Figure 4.1.6

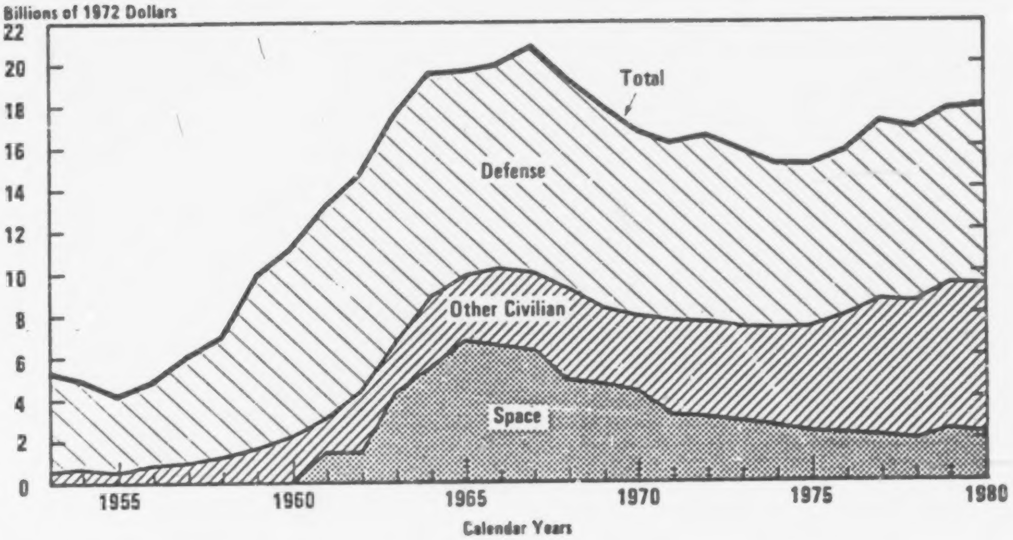
TOTAL R&D BY TYPE AND PERFORMER, 1953 - 1982



Source: National Science Foundation. Special Report NSF 84-304

Figure 4.2.1

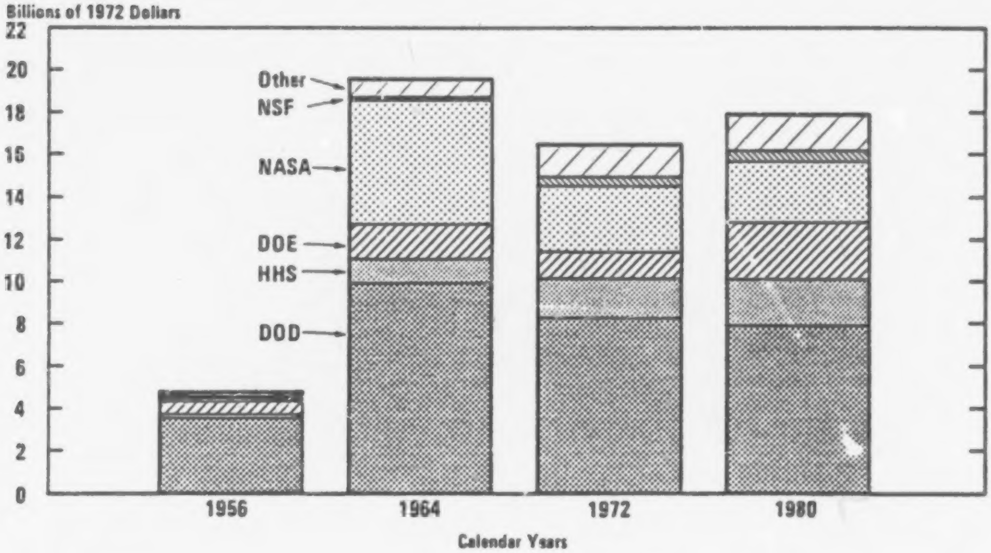
Federal R&D by Budget Function, 1953-1980



Source: National Science Foundation. Special Report NSF 84-304

Figure 4.2.2

Federal R&D by Agency, 1956, 1964, 1972, and 1980



Source: National Science Foundation. Special Report NSF 84-304

Table 4.2.3

FEDERAL BASIC AND APPLIED RESEARCH FUNDING, BY FIELD OF SCIENCE FOR CALENDAR YEARS 1967, 1980, AND 1984 (In percent shares and total funding in current and 1981 dollars)

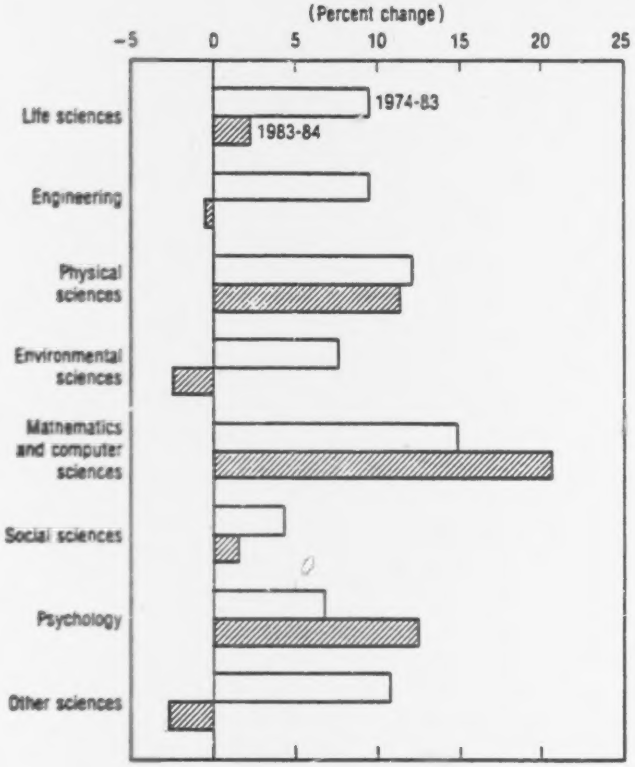
Field	1967 a/	1980 a/	1984 b/
	Major Fields		
Biology, Medicine, Psychology	31.4	37.9	37.7
Physical Sciences	20.3	17.3	21.7
Mathematics and Computer Sciences	2.8	2.1	3.3
Environmental Sciences	8.2	10.9	8.1
Social Sciences	4.1	4.5	2.9
Engineering	30.8	24.4	23.8
Other	2.5	3.0	2.5
Total	100.0	100.0	100.0
Addendum: Total Dollar Funding			
In billions of current dollars	4.6	11.6	14.7
In billions of 1981 dollars	11.5	12.7	12.6
	Selected Fields		
Physical Sciences			
Physics	58.2	59.1	65.4
Chemistry	24.1	22.7	16.6
Astronomy	12.8	14.3	10.6
Other	4.9	3.9	7.3
Total	100.0	100.0	100.0
Addendum: Total Dollar Funding			
In billions of current dollars	0.9	2.0	3.2
In billions of 1981 dollars	2.3	2.2	2.7

NOTE: Percent shares may not add to 100 percent because of rounding.

Source: National Science Foundation. Special Report NSF 84-304

Figure 4.2.4

Federal Research Obligations by Field of Science and Engineering in Selected Periods[a]



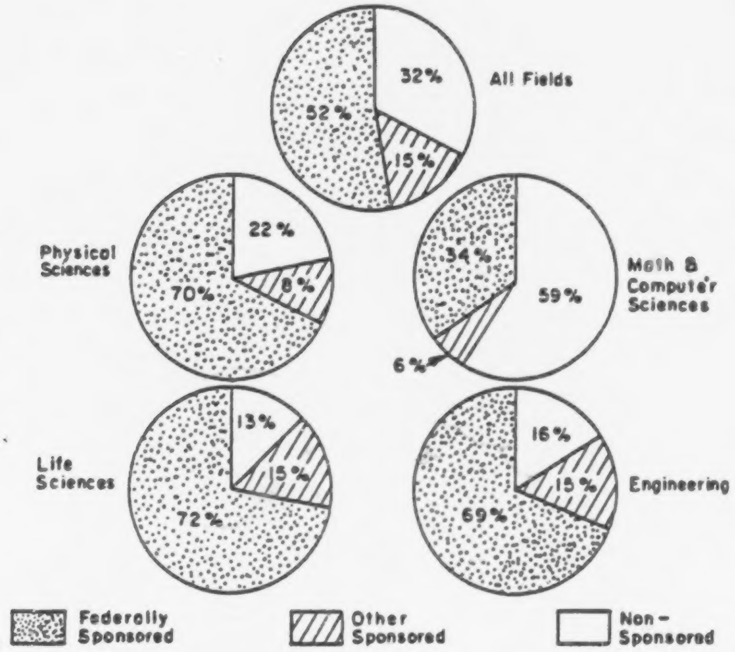
[a] Average annual percent change for the 1974-83 period; percent change for 1983-84.

SOURCE: National Science Foundation

Reprinted from NSF 84-302

Figure 4.2.5

RESEARCH TIME IN UNIVERSITIES: November 1978 - October 1979



Source: National Science Foundation

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Table 4.3.1

Budget Authority for Basic Research by Function

[Dollars in millions]

Function	1982	1983	1984
	Actual	Estimates	
Total	$5,305	$5,895	$6,401
General science	1,296	1,430	1,661
National Science Foundation	913	995	1,181
Department of Energy	383	435	480
All other functions	4,009	4,465	4,740
Health	1,953	2,183	2,238
National defense	696	788	869
Space research and technology	434	485	529
Agriculture	295	325	343
Energy	260	286	322
Transportation	102	120	153
Natural resources and environment	139	144	145
Education, training, employment, and social services	78	80	88
Commerce and housing credit	17	18	17
Veterans benefits and services	13	15	15
International affairs	10	10	10
Community and regional development	7	5	6
General government	2	3	4
Administration of justice	4	4	2
Income security	—	—	—

SOURCE: National Science Foundation

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Table 4.3.2

Federal R&D Funding by Budget Function[1]

[Dollars in millions]

Function	Actual									Estimates	
	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
Total	$17,410	$19,039	$20,780	$23,542	$25,999	$28,080	$30,017	$33,319	$36,115	$38,455	$45,663
National defense	9,016	9,679	10,430	11,864	12,899	13,791	14,946	18,413	22,070	24,913	31,984
Health	2,069	2,170	2,351	2,629	2,968	3,401	3,694	3,871	3,869	4,249	4,356
Energy	759	1,363	1,649	2,562	3,134	3,461	3,603	3,501	3,012	2,580	2,306
Space research and technology	2,702	2,764	3,130	2,924	2,962	3,009	2,981	2,696	2,584	1,883	1,897
General science	749	813	858	974	1,050	1,119	1,233	1,340	1,359	1,492	1,720
Transportation	693	635	631	708	768	798	888	870	791	894	1,091
Natural resources and environment	516	624	683	753	904	1,010	999	1,061	965	927	788
Agriculture	313	342	383	457	501	552	585	659	693	747	748
Education, training, employment, and social services	236	239	255	230	345	354	468	298	228	220	226
International affairs	24	29	42	66	57	117	127	160	165	152	161
Veterans benefits and services	85	95	98	107	111	123	126	143	139	158	159
Commerce and housing credit	51	65	69	71	77	93	102	106	104	107	91
Income security	71	72	48	55	67	57	77	43	32	42	43
Administration of justice	35	44	35	30	44	47	45	34	31	33	42
Community and regional development	82	93	109	101	92	127	119	104	63	48	39
General government	9	12	12	13	20	23	22	22	10	10	12

[1] Listed in descending order of 1984 budget authority. Data for 1974-77 are shown in obligations; data for 1978-84 are shown in budget authority. Data for 1983 and 1984 are estimates as shown in the 1984 budget published in January 1983.

NOTE: Detail may not add to totals because of rounding.

SOURCE: National Science Foundation

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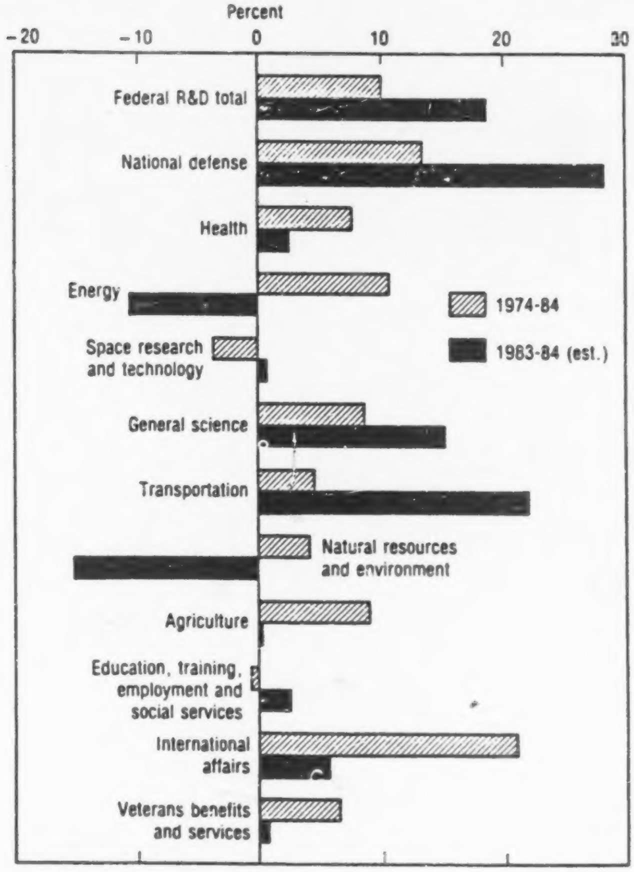
Figure 4.3.3

Relative Changes for Federal R&D Budget Functions[a]



[a]Shown in descending order of 1984 R&D budget authority.

NOTE: Based on obligations for 1974 and budget authority for 1983-84

SOURCE: National Science Foundation

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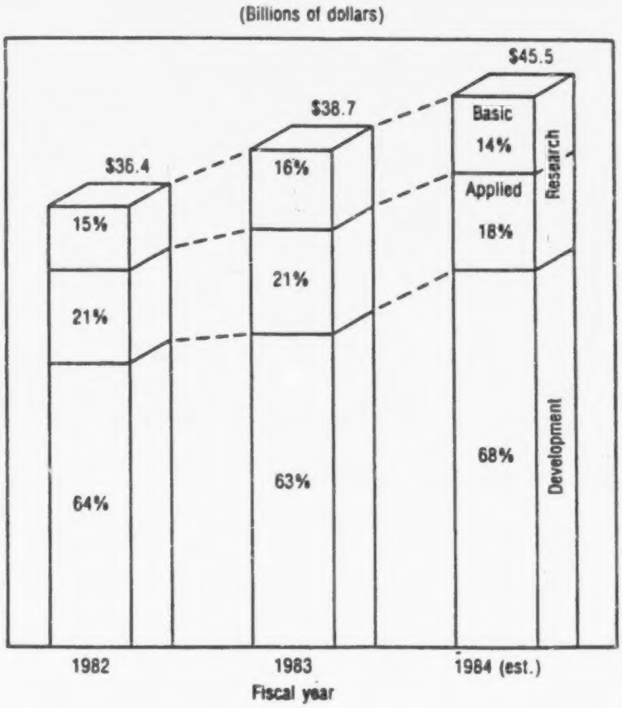
Figure 4.3.4

Federal Obligations for Research and Development by Character of Work



SOURCE: National Science Foundation

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Federal Obligations for Research and Development by Performer: Fiscal Years 1974 and 1982-84

[Dollars in millions]

Performer	Actual			Estimated			
	1974	1982	Annual average percent change 1974-82	1983	Percent change 1982-83	1984	Percent change 1983-84
Total	$17,410	$36,433	9.7	$38,710	6	$45,497	18
Federal intramural	4,911	9,141	8.1	10,228	12	10,970	7
Industrial firms[1]	8,345	18,698	10.6	19,254	3	24,571	28
Universities and colleges	2,214	4,606	9.6	4,996	9	5,271	6
FFRDC's administered by universities	789	1,977	12.2	2,089	6	2,292	10
Other nonprofit institutions	672	1,092	6.3	1,177	8	1,336	14
FFRDC's administered by other nonprofit institutions	199	521	12.9	568	9	683	20
State and local governments	214	184	-1.9	210	14	189	-10
Foreign	65	214	16.1	188	-12	185	-2

[1] Includes federally funded research and development centers (FFRDC's) administered by this sector.

SOURCE: National Science Foundation

Reprinted from NSF 84-302

Table 4.4.1

PROGRAMS SUPPORTING CHEMISTRY AT NATIONAL SCIENCE FOUNDATION

($ Thousand)

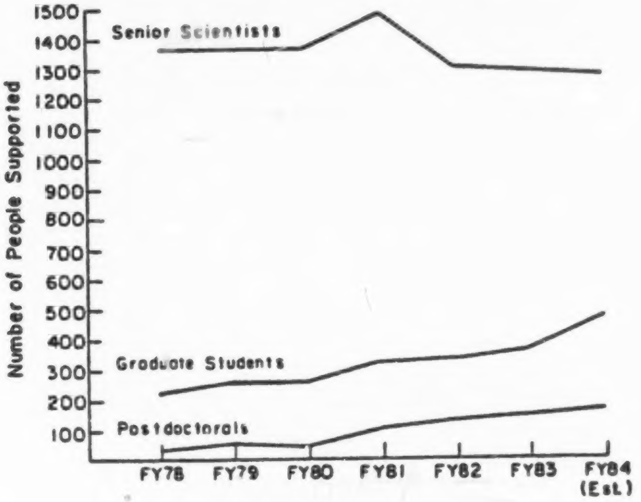
	FY 1983 Actual	FY 1984 Estimate	FY 1985 Request	% Change FY 1984 - FY 85
FUNDED BY CHEMISTRY DIVISION				
Structural & Thermodynamics	$ 12,952	$ 13,650	$ 15,470	+13.3%
Chemical Physics	10,653	13,110	14,780	+12.7
Chemical Dynamics	13,606	14,460	16,950	+17.2
Chemical Analysis	7,138	7,860	9,120	+16.0
Synthetic Inorganic & Organometallic	7,083	7,860	9,120	+16.0
Synthetic Organic & Natural Products	8,352	9,730	11,310	+16.2
Chemical Instrumentation	7,844	11,630	13,500	+16.1
Subtotal, Chemistry Division	$ 67,628	$ 80,000	$ 92,090	+15.1%
FUNDED BY MATERIALS RESEARCH DIVISION				
Solid State Chemistry	$ 6,480	$ 7,670	$ 8,990	+17.2%
Polymers	5,489	6,380	7,570	+18.7
Instrumentation for Materials Research	3,993	6,470	7,780	+20.2
Materials Research Labs	23,428	26,503	30,09	+13.5
National Facilities	7,540	10,460	12,110	+15.8
Subtotal, Materials Research	$ 46,930	$ 57,483	$ 66,540	+15.8%
OTHER PROGRAMS INVOLVING CHEMISTRY				
Biochemistry	$ 11,382	$ 12,850	$ 14,650	+14.0%
Atmospheric Chemistry	5,592	6,700	7,250	+ 8.2
NCAR Chemistry	2,114	2,363	2,386	+ 1.0
Volcanology & Mantle Geochemistry	2,602	3,600	3,900	+ 8.3
Experimental & Theoretical Geochemistry	4,924	5,700	6,100	+ 7.0
Marine Chemistry	10,798	12,000	13,400	+11.7
Subtotal, Other Chemistry	$ 37,412	$ 43,213	$ 47,686	+10.4%
TOTAL, ALL PROGRAMS INVOLVING CHEMISTRY	$151,970	$180,696	$206,316	+14.2%

Source: National Science Foundation

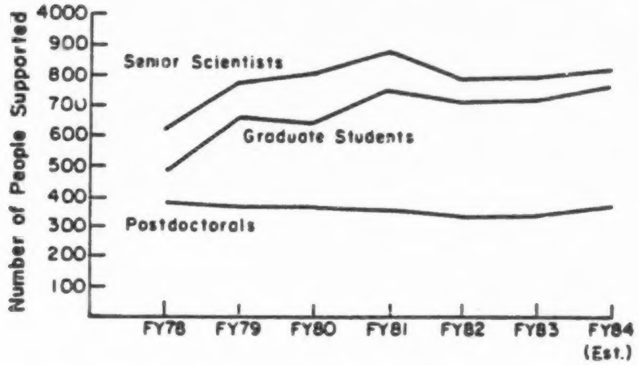
Reprinted from AAAS Report IX: Research and Development FY 1985, American Association for the Advancement of Science, 1984.

Figure 4.4.2

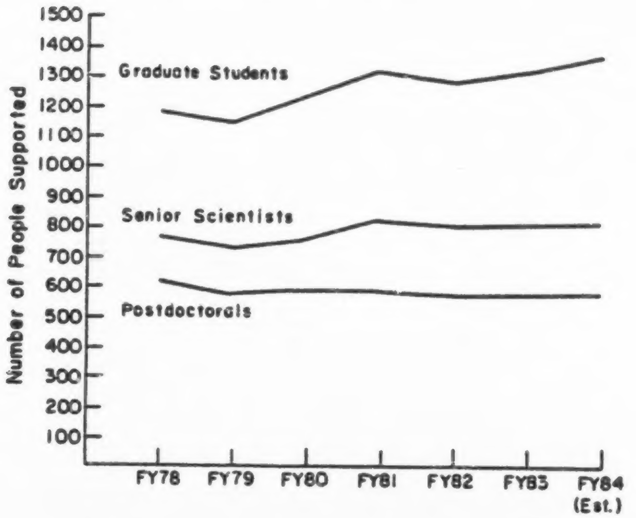
PERSONNEL: MATHEMATICAL SCIENCES - NSF



PERSONNEL: PHYSICS - NSF



PERSONNEL: CHEMISTRY - NSF



Source: National Science Foundation

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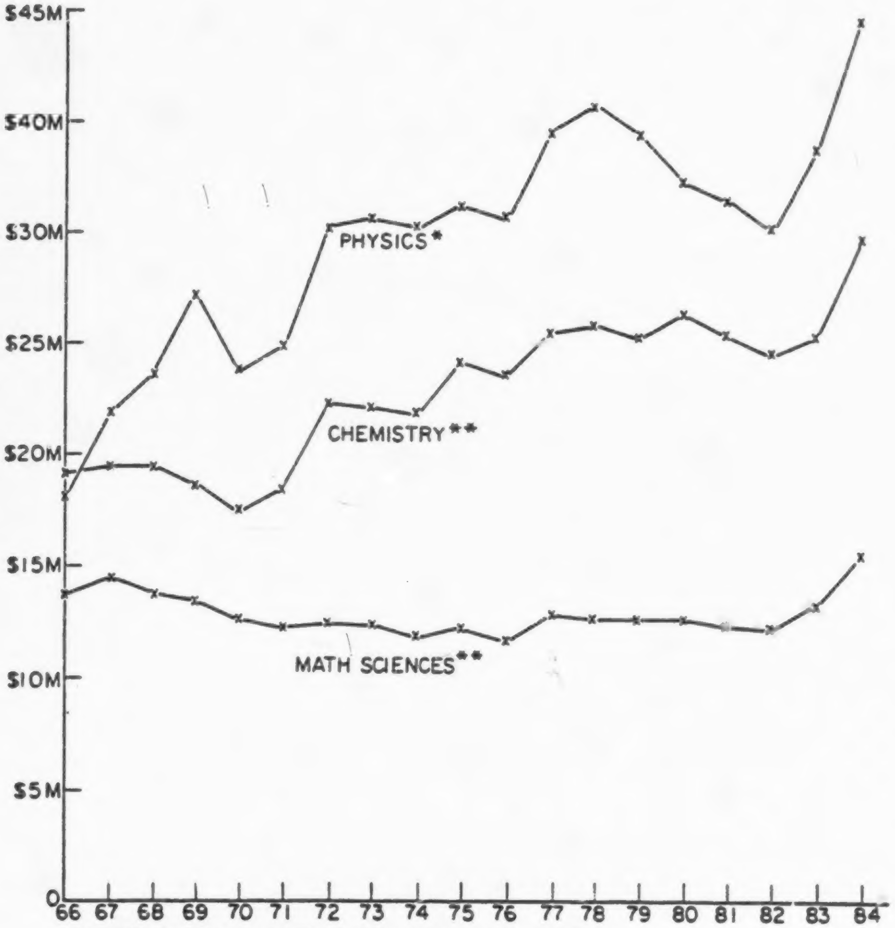
Figure 4.4.3

CONSTANT DOLLAR NSF SUPPORT OF THREE FIELDS OF SCIENCE
FY66-FY84 (1969 DOLLARS, CPI DEFLATOR)



SOURCE: NATIONAL SCIENCE FOUNDATION BUDGET
*SOLID STATE AND LOW TEMPERATURE PHYSICS NOT INCLUDED.
**COMPUTER SCIENCE NOT INCLUDED.

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Table 4.5.1

SUPPORT OF BASIC RESEARCH IN CHEMISTRY AT DEPARTMENT OF DEFENSE*
($ Million)

	FY 1983 Actual	FY 1984 Estimate	FY 1985 Request	% Change FY 1984 - FY 85
CHEMISTRY				
Army	$23.8	$23.5	$25.4	+ 8.1%
Navy	18.2	19.0	20.9	+10.0
Air Force	16.9	19.5	20.0	+ 2.6
TOTAL	$58.9	$62.0	$66.3	+ 6.9%
MATERIALS				
Army	$17.0	$17.1	$18.1	+ 5.8%
Navy	24.0	25.0	27.5	+10.0
Air Force	17.7	21.9	22.7	+ 3.7
DARPA	22.3	18.8	19.2	+ 2.1
TOTAL	$81.0	$82.8	$87.5	+ 5.7%

* Consists of funds classified under budget category "6.1".

Source: Department of Defense, Office of the Undersecretary of Defense for Research and Engineering.

Reprinted from AAAS Report IX: Research and Development FY 1985, American Association for the Advancement of Science, 1984.

Table 4.5.2

CHEMICAL SCIENCES - DEPARTMENT OF ENERGY
($ Thousand)

	FY 1983 Actual	FY 1984 Estimate	FY 1985 Request	% Change FY 1984 - FY 85
Fundamental Interactions				
Photo- & Radiation Chemistry	$20,955	$22,515	$24,960	+ 10.9%
Chemical Physics	16,176	17,367	18,464	+ 6.3
Atomic Physics	6,367	6,870	7,240	+ 5.4
Processes and Techniques				
Chemical Energy	13,447	14,441	15,118	+ 4.7
Separations & Analysis	11,221	11,900	12,520	+ 5.2
Chemical Engineering Sciences	1,834	2,407	2,628	+ 9.2
TOTAL, OPERATING EXPENSES	$70,000	$75,500	$80,930	+ 7.2%
CAPITAL EQUIPMENT	$ 5,510	$ 6,520	$ 8,840	+ 35.6%
CONSTRUCTION	$ 400	$ 450	$ 8,050	+168.9%

Source: Department of Energy

Reprinted from AAAS Report IX: Research and Development FY 1985, American Association for the Advancement of Science, 1984.

Table 4.5.3

PROGRAMS SUPPORTING CHEMISTRY AT DEPARTMENT OF ENERGY
($ Thousand)

	FY 1983 Actual	FY 1984 Estimate	FY 1985 Request	% Change FY 1984 - FY 85
Basic Energy Sciences				
Materials Chemistry	$ 12,300	$ 13,380	$ 14,790*	+10.5%
Chemical Sciences	70,000	75,500	80,930	+ 7.2
Nuclear Science - Heavy Element Chemistry	4,406	4,691	5,125	+ 9.3
Geochemistry	3,942	3,352	3,610*	+ 7.7
University Research Support				
University Lab Coop. Research	4,284	3,500	6,550	+87.1
Biological and Environment Research				
Source and Dose Determination	10,275	10,161	10,300	+ 1.4
Environmental Fate and Behavior	29,498	28,267	32,726	+15.8
Solar and Other Renewables**	139,009	130,500	122,285	- 6.3
Energy Storage	25,100	25,700	16,603	-35.4
Coal***	195,150	185,140	156,642	-15.4
Petroleum	23,750	30,300	31,600	+ 4.3
Industrial Energy Conservation				
Waste Energy Reduction	11,963	12,000	12,350	+ 2.9
Industrial Process Efficiency	7,700	14,200	8,000	-43.7
Multi-Sector Energy Conservation				
Energy Conversion and Utilization Technologies	9,000	9,000	17,850	+98.3
TOTAL, ALL PROGRAMS INVOLVING CHEMISTRY - OPERATING EXPENSES	$546,377	$545,691	$519,361	- 4.8%

* Estimate. ** Excludes Wind, Ocean, International, Technology Transfer, Geothermal, and Hydropower programs. *** Excludes Heat Engines and Fuel Cells programs.

Source: Department of Energy

Reprinted from AAAS Report IX: Research and Development.FY 1985, American Association for the Advancement of Science, 1984.

Table 4.5.4

PROGRAMS SUPPORTING CHEMISTRY AT EPA
($ Thousand)

		FY 1983 Actual	FY 1984 Estimate	FY 1985 Request	% Change FY 1984 - FY 85
Monitoring Systems & Quality					
Assurance:	In-house	$ 14,110.5	$ 12,520.6	$ 14,024.7	+ 12.0%
	Extramural	15,218.4	14,774.5	16,940.5	+ 14.7
Subtotal		$ 29,328.9	$ 27,295.1	$ 30,965.2	+ 13.4
Environmental Engineering &					
Technology:	In-house	$ 18,927.4	$ 14,152.3	$ 16,240.9	+ 14.8%
	Extramural	37,170.4	34,921.3	33,697.1	- 3.5
Subtotal		$ 56,097.8	$ 49,073.6	$ 49,938.0	+ 1.8
Environmental Processes					
& Effects:	In-house	$ 1,222.7	$ 1,128.4	$ 992.9	+ 12.0%
	Extramural	1,851.8	946.2	900.2	- 4.9
Subtotal		$ 3,074.5	$ 2,074.6	$ 1,893.1	- 8.7%
Exploratory Research:	In-house	$ 1,595.9	$ 441.3	$ 578.5	+ 31.1%
	Extramural	4,910.2	16,512.3	15,160.0	- 8.2
Subtotal		$ 6,506.1	$16,953.6	$ 15,738.5	- 7.2%
Acid Rain:	In-house	$ 820.4	$ 590.5	$ 952.5	+ 61.3%
	Extramural	12,250.3	14,784.3	33,412.5	+126.0
Subtotal		$ 13,070.7	$ 15,374.8	$ 34,365.0	+123.5%
ALL PROGRAMS	In-house	$ 36,676.9	$ 28,833.1	$ 32,789.5	+ 13.7%
INVOLVING CHEMISTRY	Extramural	71,401.1	81,938.6	100,110.3	+ 22.2
	TOTAL	$108,078.0	$110,771.7	$132,899.8	+ 20.0%

Source: Environmental Protection Agency

Reprinted from AAAS Report IX: Research and Development FY 1985, American Association for the Advancement of Science, 1984.

PROGRAMS SUPPORTING CHEMISTRY AT NATIONAL BUREAU OF STANDARDS
($ Thousand)*

	FY 1983 Actual	FY 1984 Estimate	FY 1985 Request	% Change FY 1984 - FY 85
Measurement Research & Standards (M&S)				
Analytical Chemical M&S	$ 2,383	$ 2,624	$ 2,810	+ 7.1%
Chemical Properties and Processes	3,275	3,631	6,881	+ 89.5
Materials Characterization, Processing & Performance	14,560	14,937	17,758	+ 18.9
Other Programs Supporting Chemistry				
Chemical Engineering Metrology	$ 3,738	$ 4,136	$ 4,424	+ 7.0%
Fire Research	5,976	5,827	0	-100.0
Building Research	4,113	3,174	0	-100.0
Technical Competence Fund	7,145	8,169	8,727	+ 6.8
TOTAL, ALL PROGRAMS INVOLVING CHEMISTRY	$41,190	$42,498	$40,600	- 4.5%

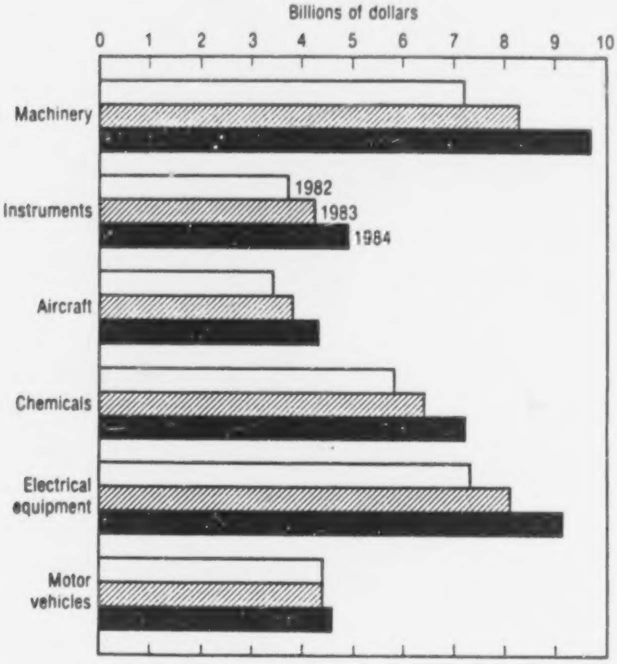
* Figures include special equipment, and overhead.

Source: National Bureau of Standards

Reprinted from AAAS Report IX: Research and Development FY 1985, American Association for the Advancement of Science, 1984.

Figure 4.6.1

Estimated company-funded R&D expenditures in the six leading R&D-performing industries



SOURCE: National Science Foundation

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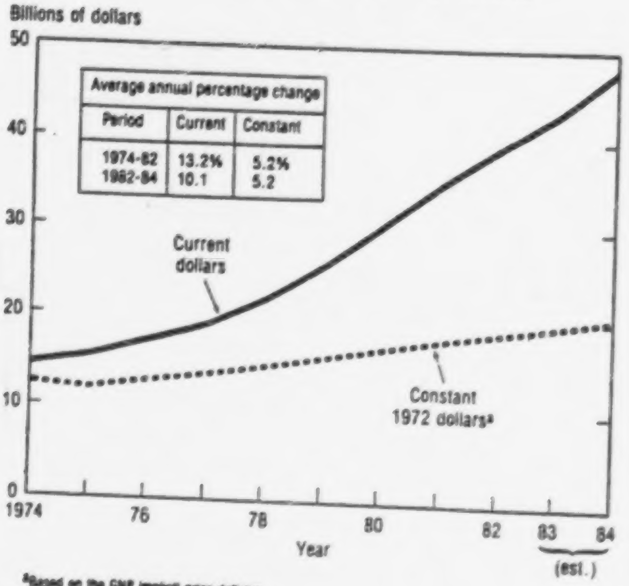
Figure 4.6.2

Company-funded R&D Expenditures



Average annual percentage change		
Period	Current	Constant
1974-82	13.2%	5.2%
1982-84	10.1	5.2

[a] Based on the GNP implicit price deflator

SOURCE: National Science Foundation

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Table 4.6.3

ESTIMATED PRIVATE R&D SPENDING: 1979-1983

Industry	Percent of Sales					5 Year Growth Rate (% of Total R&D Expenditures)
	1979	1980	1981	1982	1983	
Aerospace	4.2	4.5	4.8	5.1	4.6	17.7
Automobiles	3.2	4.0	3.7	4.0	3.5	4.4
Chemicals	2.3	2.4	2.5	2.9	3.0	16.7
Drugs	4.8	4.9	5.3	6.0	6.7	18.1
Electrical	2.8	2.8	2.9	2.8	3.0	12.0
Electronics	2.5	2.9	3.1	5.3	4.3	19.7
Petroleum	0.4	0.4	0.5	0.5	0.6	21.6
Computers and Peripherals	6.1	6.3	6.4	6.8	7.2	17.9
Office Equipment	4.2	4.3	5.0	5.1	5.8	18.0
Instruments	3.9	4.2	4.6	5.2	5.5	17.2
Machinery	1.6	1.6	1.9	2.6	3.4	5.1
Nonferrous Metals	0.5	0.9	1.1	1.2	1.1	8.3
Semiconductors	5.7	6.0	7.1	7.8	8.1	24.8
Steel	0.6	0.6	0.6	0.7	0.6	10.9
Telecommunications	1.0	1.0	1.2	1.3	1.4	20.8
Textiles	0.6	0.5	0.4	0.6	0.7	18.7
Tire and Rubber	1.7	1.8	2.0	2.3	2.3	8.2

SOURCE: Business Week, (July 7,1980, July 6, 1981, July 5, 1982, June 20,1983 and March 22, 1985).

Table 4.6.4

Company Funds for Research and Development by Selected Industry: Actual 1981 and 1982, and Projected 1983 and 1984

[Dollars in billions]

Selected industry	SIC code	1981 actual	1982 prelim- inary	1983 pro- jected[1]	1984 pro- jected[1]
Total	....	$35	$40	$44	$48
Chemicals and allied products	28	5	6	7	7
Machinery	35	6	7	8	10
Electrical equipment	36	6	7	8	9
Motor vehicles and motor vehicles equipment	371	4	4	4	5
Aircraft and missiles	372,376	3	4	4	5
Professional and scientific instruments	38	3	3	4	4
All other	....	7	8	8	9

[1] Projections made on the basis of contacts with industrial R&D officials.

SOURCE: National Science Foundation

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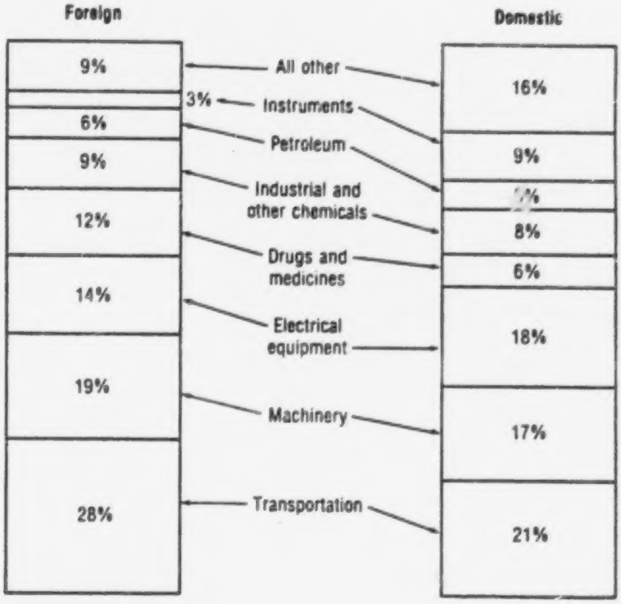
Figure 4.6.5

Distribution of Company-Funded Foreign and Domestic R&D Expenditures Among Major R&D-Performing Industries: 1981



SOURCE: National Science Foundation

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Company Research and Development Performed by Foreign Affiliates of U.S. Domestic Companies Outside the United States by Selected Industry: 1974-81

[Dollars in millions]

Industry	SIC code	1974[1]	1975	1976	1977	1978	1979	1980	1981
Total		$1,300	$1,454	$1,659	$1,877	$2,209	$2,754	$3,165	$3,157
Food and kindred products	20	27	23	29	32	43	51	54	66
Chemicals and allied products	28	208	269	312	332	395	500	603	651
Industrial and other chemicals	281-82,284-89	82	85	108	133	151	199	245	275
Drugs and medicines	283	126	184	204	199	244	301	357	376
Petroleum refining and related industries	29	(2)	(2)	(2)	(2)	(2)	(2)	141	192
Stone, clay, and glass products	32	7	7	(3)	(3)	(3)	(3)	21	15
Primary metals	33	3	9	12	9	9	11	11	9
Fabricated metal products	34	(2)	(2)	22	24	29	(3)	(3)	(3)
Machinery	35	258	331	352	411	460	534	599	585
Electrical equipment	36	238	245	278	300	352	445	451	455
Electronic components	367	4	7	9	13	17	25	29	47
Other electrical equipment	361-64,369	(3)	(3)	6	5	9	11	11	12
Radio and TV receiving equipment; communication equipment	365-66	(3)	(3)	(3)	(3)	(3)	(3)	(3)	(3)
Transportation	37	406	412	464	558	640	874	1,020	893
Motor vehicles and other transportation equipment	371,373-375,379	364	373	423	514	(3)	(3)	(3)	(3)
Aircraft and missiles	372,376	42	39	41	44	(3)	(3)	(3)	(3)
Professional and scientific instruments	38	39	49	49	51	61	76	86	101
Other manufacturing industries	21-27,30-31,39	111	105	137	144	181	213	139	147
Nonmanufacturing industries	07-17,41-67,737, 739,807,891	3	4	4	9	12	5	7	12

[1] Based on data obtained from the top 200 U.S. R&D performing companies.

[2] Included in the other manufacturing industries group.

[3] Not separately available but included in total.

Note: Data are reported in current U.S. dollars.

SOURCE: National Science Foundation

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